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CANADIAN ELECTRONICS ENGINEERING

NOVEMBER 1959
A Maclean-Hunter publication
five dollars a year

Electronics engineers can work for peace 21

How to design transistor power amplifiers 22

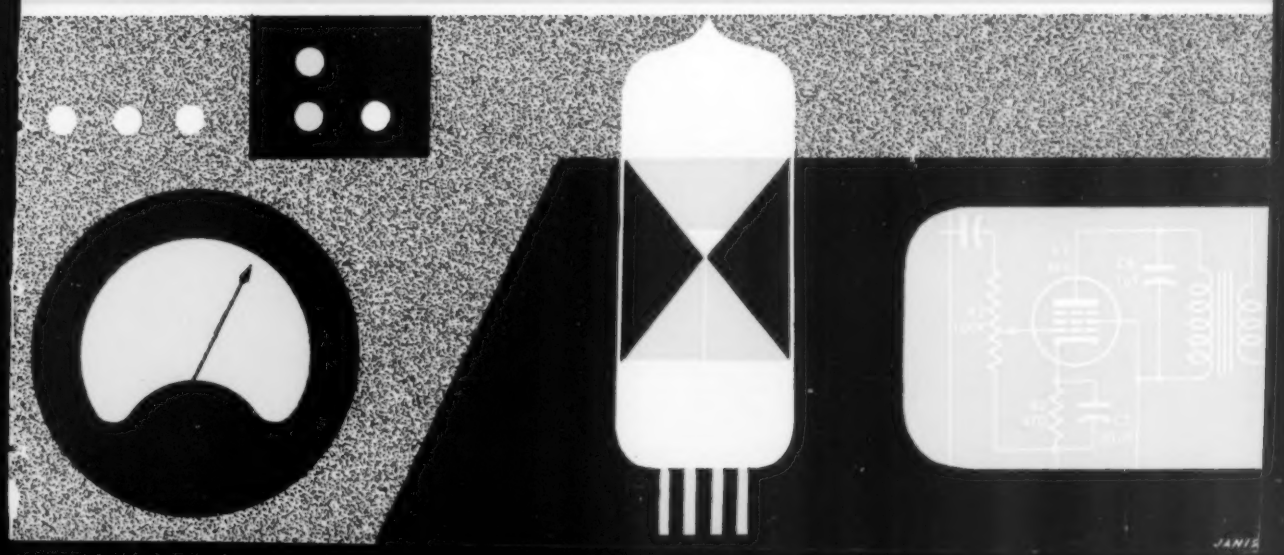
Latest data on earth's environment. Part 2 26

Does pre-ageing of tubes pay off? 31

Engineering reports 32

1959 IRE Canadian Convention report 38

full contents 1



SHAGGY FISH STORY

At the height of the Boston Tea Party, while the "Indians" were busy throwing everything in sight over the side, the British radar operator suddenly found himself pitched overboard.

Since he couldn't swim, he clung precariously to a wooden tea case bobbing in the water, and floated aimlessly around, thrashing wildly and yelling for help.

Just as he was about to lose his grip on his precious raft, a codfish surfaced nearby.

"What's going on here?" the codfish asked.

"Some wild Indians surprised our radar, overran the ship, and threw all the tea overboard," the radar man gasped.

"Well," the codfish said, "Bet you a fin you didn't have any Bomac tubes in that radar of yours."*

"Good cod, here I am drowning in front of your eyes and you have to give me a commercial," the man said. "I can't hang on much longer!"

The fish ignored him. "... Anybody knows Bomac makes the finest microwave tubes and components either side of Boston Harbor," he said.

"Look," the man said. "I've just about haddock. But tell me this: How do you know so much about microwaves?"

"I'm no expert," the codfish said. "I just dabble in it for the halibut."

"O," the man said. And he sank silently into the sea.

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November, 1959

CANADIAN ELECTRONICS ENGINEERING

Volume three, number 11

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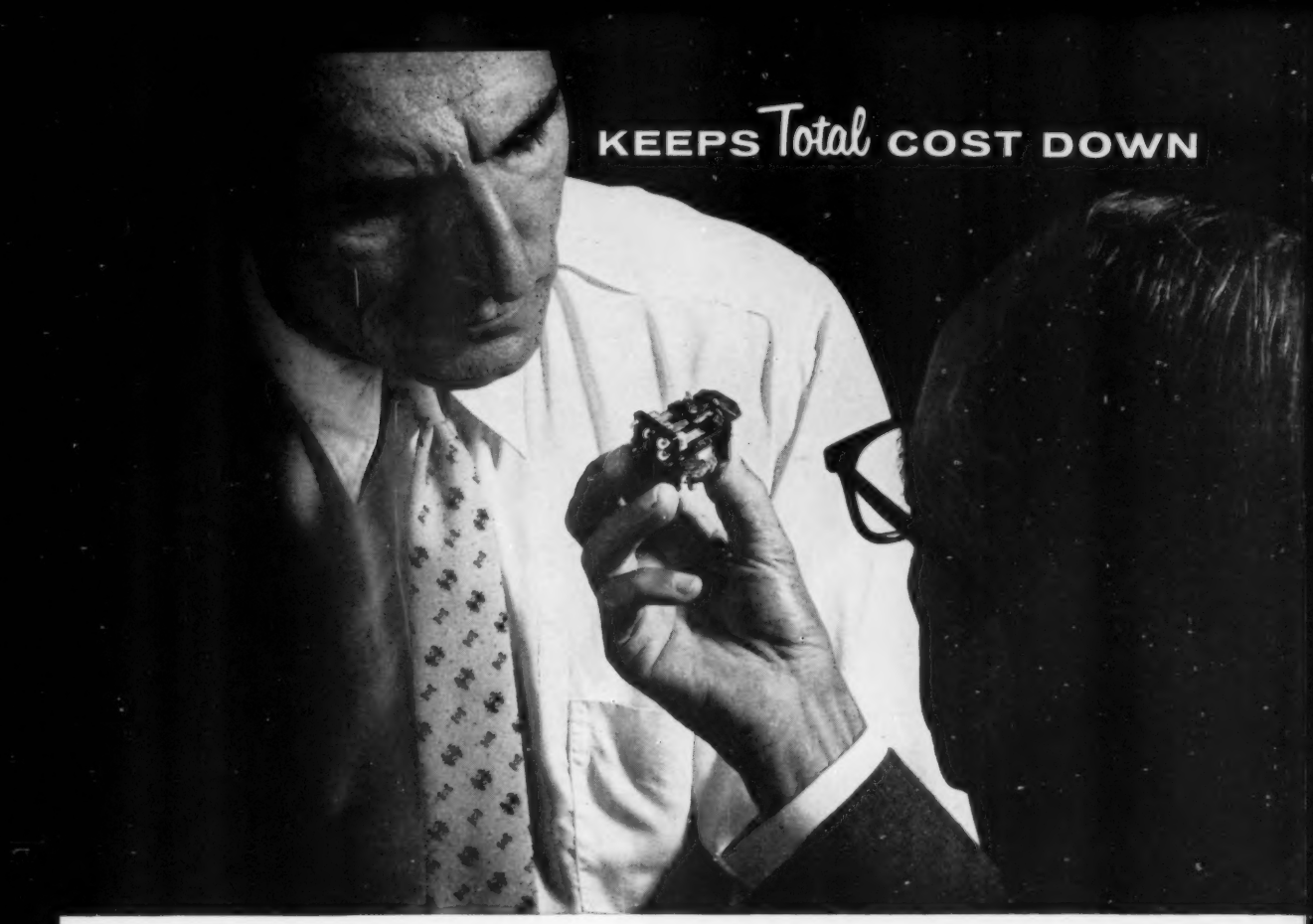
*** cover design**

How do you pre-age electron tubes, and is it worth while economically? With these questions in mind, artist Janis produced this month's cover.



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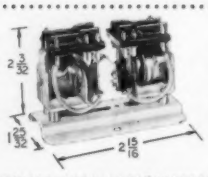
Write or call for more information or see the complete P&B catalog in Sweet's Product Design File.



KB LATCHING RELAY consists of two KA Relays, forming a mechanical latching relay, featuring a large number of contact arrangements.

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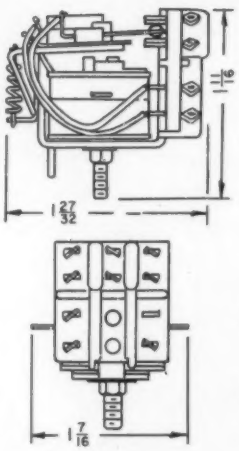

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- **Breakdown Voltage:** 1500 V. rms between all elements.
- **Temperature Range:** −55° C. to +85° C. DC; −55° C. to +70° C. AC
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- **Pull-In:** DC 75% of nominal voltage. AC 78% of nominal voltage.
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- **Load:** 5 amps @ 115 V. AC 60 cps res.

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Authorized as second class mail, Post Office Department, Ottawa.

Printed and published by Maclean-Hunter Publishing Company Limited, 481 University Avenue, Toronto 2, Canada. Address all correspondence: P.O. Box 100, Toronto, Canada. EM. 3-5981.

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Subscription rates: Canada $5.00 per year, two years $8.00, three years $13.00. Single copy price $1.00. U. S. A., United Kingdom, $10.00 per year; all other countries, $20.00 per year.

Indexed in Engineering Index.

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contributors and special articles in this issue:

In his second article in CEE, **Stanley Pinnell** (Does pre-ageing of tubes pay off?) describes and draws some conclusions from a series of tests carried out in 1956. The results have not been published before and will, we think, be of particular interest to our many readers concerned with equipment reliability and the cost of increasing it.

Mr. Pinnell received his Master's degree from the University of Alberta shortly after World War II. He has been with Pylon Electronic Development company ltd. since 1955, where he now fills the dual role of president and sales manager.

Another author presenting his second article this month is **H. L. Armstrong** (How to design transistor power amplifiers).

Mr. Armstrong was born near Picton, Ont. and lived there until he joined the Army in 1941. He served with the First Surrey Regiment, Royal Canadian Artillery, in Britain, Italy, and Northwestern Europe. After the war he entered the Faculty of Applied Science at Queen's University and graduated with an honors degree, B.Sc in Physics, 1950. He continued his studies at Queen's, having as a thesis project a study of the dielectric constants of gases at microwave frequencies, and was awarded the degree of M.Sc in Physics in 1951.

In the next few years Mr. Armstrong was employed by the National Research Council at Ottawa, the Clevite Corp. at Cleveland, O., and Pacific Semiconductors Inc., at Culver City, Calif. His work during that time was concerned primarily with semiconductor devices, and included experimental and theoretical studies of their characteristics, interspersed with some production trouble-shooting. He also did work on electronics and circuitry, instrumentation, and magnetic recording.

In September of 1958 Mr. Armstrong joined the staff of Queen's University, where he is an Assistant Professor in the Department of Physics.

Part 2 of "What's up there? . . . A summary of latest data on earth's environments up to 1,000 kilometers", by **A. P. Harris** and **E. W. Parrott,** continues with the discussion on Gases. Then it goes on to investigate Fields, Radiation Energy and Particles. Biographies of the authors were given in the October issue of CEE.

The 1959 IRE Canadian Convention and Exposition is history now. CEE is proud to be a part of that history, and pleased to be able to publish a full report of an event that was successful on almost every count. The story begins on page 38.

Parrott

Harris

Armstrong

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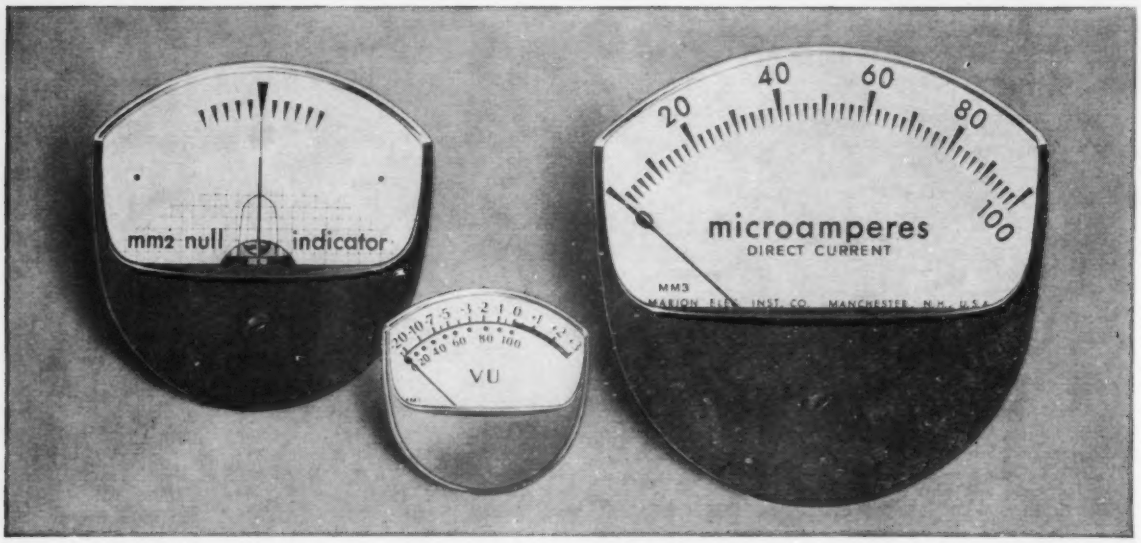

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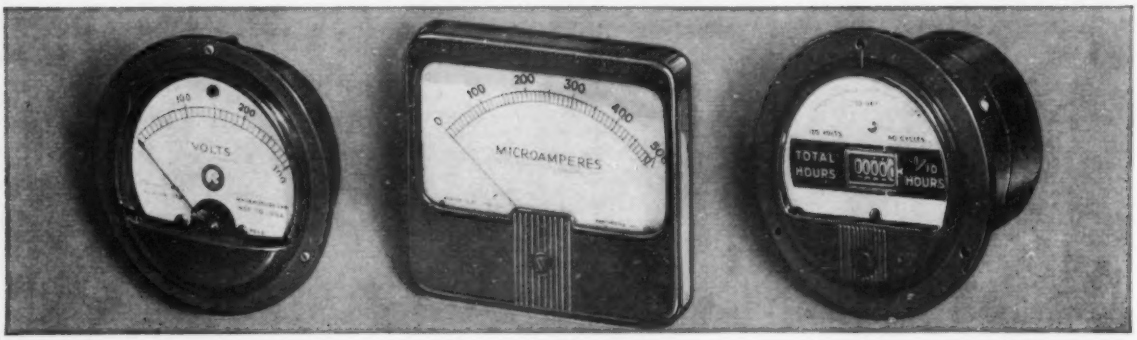

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NEWS HIGHLIGHTS

Canadian Westinghouse has received a contract for production of the weapon control system for the F-104G aircraft being built by Canadair for the RCAF.

This is one of the largest peacetime contracts ever received by Westinghouse from the Canadian government. See page 9 for further details.

Canadian government has ordered that the name of the country of origin must appear on imported electronic tubes.

The order, PC 1959-1204 of September 17, is effective December 1, 1959 and states that after that date "all importations of . . . electronic tubes must be marked so as to indicate their country of origin." Permanent methods of marking are specified for both glass and metal envelopes. David Sim, deputy minister of customs, said the action was taken following representations by Canadian manufacturers who argued that many consumers bought products unaware that they were not made in Canada.

The provincial government of British Columbia is to give official recognition to the technical proficiency of electronics servicemen by means of a certificate of efficiency.

The move comes as a result of several years' urging by the Radio Electronic Technicians Association. Applicants must prove 8,000 hours of practical experience (war service may be included) and pass a licensing examination. This is an excellent idea, and one which we hope the other provinces will take up, so that the public will know when they see the certificate that they are dealing with men who are fully qualified to service their receivers.

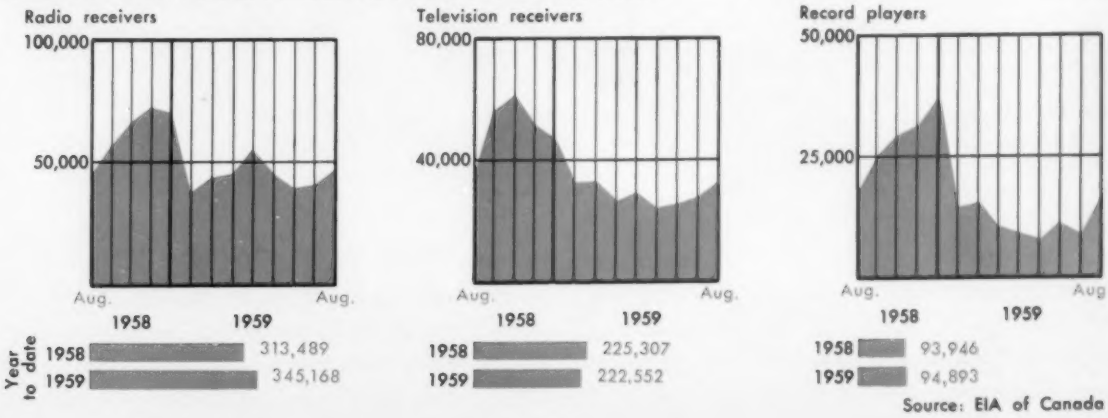
A $9,275,000 grant from the Ford Foundation will be used by Massachusetts Institute of Technology to finance major advances in engineering education.

The Ford Foundation is to be congratulated on this truly magnificent grant, which will be used to support a program of development and innovation in MIT's School of Engineering under the direction of the Dean, Dr. Gordon S. Brown. Wholly new curricula will be introduced, new forms of instructional laboratory equipment will be created, and there will be an intensive effort to educate teachers as well as engineers for the opportunities and responsibilities arising from the accelerating tempo of the world's technological change.

The Department of Transport has purchased for $2,350,000 the four-chain Decca Navigator system of continuous radio position fixing for shipping.

The evaluation of this system, now culminating in its purchase by DOT, has been a classic example of government-industry co-operation. The equipment was installed by the Decca Navigator Company of England and operated by Computing Devices of Canada Ltd., licensees of Decca. Evaluation was carried out by 400 Canadian and foreign ships and the results were studied by officials of DOT, leading to the conclusion that there is a definite need for this service. CDC will continue to operate the system until DOT takes over in about April, 1961.

Radio unit sales ahead of 1958, tv receivers hold their own



Source: EIA of Canada

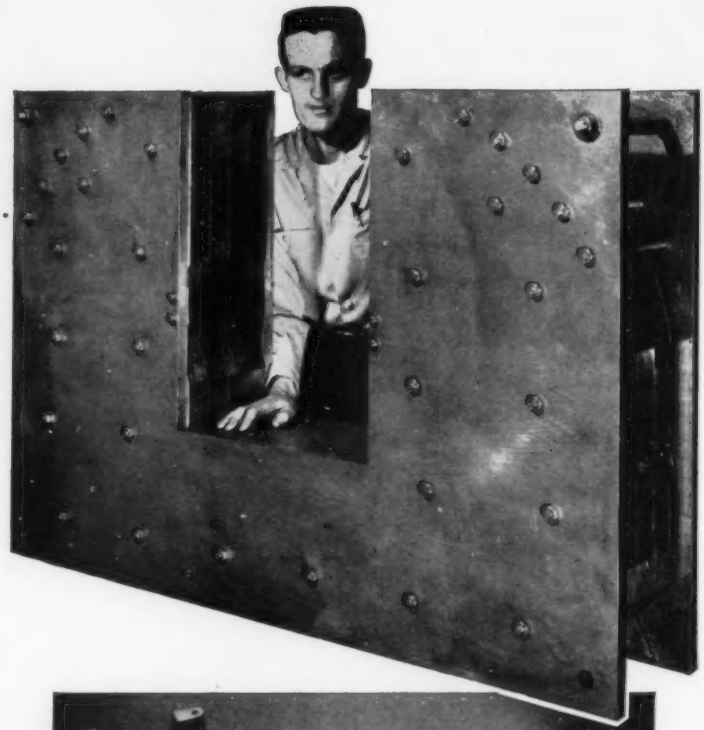
Arnold Builds World's Largest Permanent Magnet...Used in Atomic Research

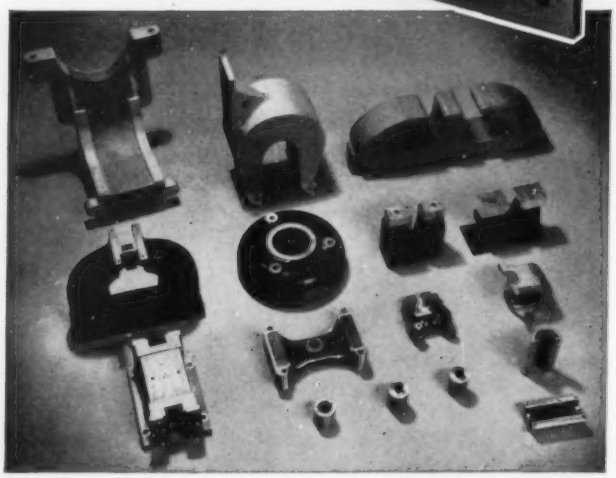
Vital Statistics on the Big Magnet

Here's how the world's champion permanent magnet weighed in: 1720 pounds of Alnico V in the assembly . . . a keeper weighing 225 pounds . . . a total shipping weight of a little over 2 tons.

Overall dimensions of the magnet assembly, as illustrated at right, were 52½" x 36" x 10", with a gap length of 16.5". The gap volume was 1584 cu. inches, and the density at the center of the gap was 1100 gausses.

Approximately 500,000 ampere turns were required to magnetize the big unit, which was shipped magnetized and keepered. It was designed for use in auxiliary equipment serving a breeder reactor for the Argonne National Laboratory, operated by the University of Chicago for the U.S. Atomic Energy Commission. Actual service is in an electro-magnetic pump for pumping fluid metals.





Top: the world's largest permanent magnet, built by Arnold for Argonne Labs, was designed to supply a field of 1100 gausses in a gap of 16½ inches. Bottom: a typical group of the permanent magnet assemblies that Arnold supplies for rotors, traveling wave tube, wave guide and magnetron magnets, mass spectrometer and other measuring applications, etc.

Vital Suggestion for Your Requirements

The facilities and wealth of experience that produced this world's largest permanent magnet are ready to bring you advantages, too.

Arnold permanent magnets are available in all types of Alnico and other magnet materials, from large castings like the Argonne unit to very small sintered parts weighing less than a gram. Many sizes and types of Alnico magnets are carried in stock for immediate delivery.

Special assemblies—such as rotors, traveling wave tube and magnetron magnets, etc. —may be supplied jacketed to facilitate mounting and give added protection to the magnet. Arnold also can supply large magnet assemblies for mass spectrometer and other measuring applications, where a high degree of stability and uniformity of field is required.

• Ask for a copy of Bulletin GC-106C, for more information on Arnold permanent magnets and other products, (tape cores, powder cores and special magnetic materials).

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Canadian engineers win award with paper on scatter system

Two Canadian engineers have won the 1958 National Electronics Conference Award for a jointly-authored technical paper presented before hundreds of top North American electronics experts.

A. J. Buxton and **M. O. Felix,** electronics engineers at the Canadian Westinghouse Company, Hamilton, won the award for their paper, "Performance of FM Scatter Systems Using Frequency Compression". The paper was adjudged the best in terms of scholarship, significance, originality, and clarity among the 100 papers presented at last October's national conference. The award, consisting of $500 and certificates, was presented this year during the 15th annual conference at Chicago.

Mr. Buxton and Mr. Felix are co-inventors of a frequency compression method of improving performance of scatter communications systems by significantly reducing undesirable noise levels. The Westinghouse-developed scatter system is used for long-range beyond-the-horizon transmission of voice, television, teletype, facsimile, telemetering, and data signals over hops of 100 to 200 miles. The company is currently undertaking scatter projects for the RCAF, U. S. Air Force, and Supreme Headquarters Allied Powers in Europe.

Chief engineer at Meredith

R. W. Naylor, P.Eng., has been appointed chief engineer at C. C. Meredith & Co. Ltd. He has been serving as design engineer with the recently acquired Industrial Electronics Division of C. C. Meredith.

Mr. Naylor was formerly with Canadian General Electric Co. Ltd. as manager of the broadcast engineering unit of the Electronic Equipment and Tube Dept. Later he was technical counselor in advanced engineering and design engineering.

Three new sales appointments

Three new appointments are announced by General Instrument - F. W. Sickles of Canada Limited.

Jack Thompson will act as assistant to Lloyd R. Harris in sales to radio and television receiver manufacturers. Mr. Thompson was formerly purchasing agent for Sylvania Electric of Canada Limited.

Representing General Instruments in the field of industrial components will be **Fred Penny** who, for several years past, has similarly represented Canadian General Electric Company.

Harold Carioni will be responsible for the sale of the company's products to electronics wholesalers. Mr. Carioni is president of Telequipment Company.

Penny

Carioni

Thompson

Vallillee

Joins sales staff of Adams Engineering

After more than seven years sales experience with J. R. Longstaffe Company, **B. D. Vallillee** has joined the sales staff of Adams Engineering Ltd. He will be working from their Toronto office.

Mr. Vallillee was born in Toronto, but moved to the United States while less than a year old. He returned after World War II and has been taking extension courses from the University of Toronto during the past few years. His position, prior to joining Adams Engineering, was sales manager of Renfrew Electric Co. Ltd., IRC Div.

Swan, Rees and friends

The annual golf tournament of the Electronic Industries Association of Canada, and the Institute of Radio Engineers attracted nearly 200 members to Toronto's Cedar Brae Golf and Country Club. E. Swan of Earnie Swan Television won the IRE Low Gross Trophy, while J. Rees of Canadian Admiral Corp. Ltd. won the EIA Low Gross Trophy.

Appointments at Saskatchewan Government Telephones

Hon. C. C. Williams, minister in charge of Saskatchewan Government Telephones has announced the appointment of **S. F. Lee** as chief engineer. Mr. Lee succeeds **C. W. Sparrow** who was made manager of operations and engineering for the system.

Mr. Lee joined the engineering department of Saskatchewan Government Telephones on May 1, 1950, following graduation in electrical engineering from the University of Saskatchewan. He has been closely associated with the microwave installation in Saskatchewan and the system's dial conversion program. He is a member of the Engineering Institute of Canada, of the Association of Professional Engineers of Saskatchewan, and IRE.

Sonar engineer promoted

In his new position as chief engineer of Edo (Canada) Ltd., **R. A. Lapetina** will be responsible for the design and development of military and commercial electronic systems, especially in the field of underwater acoustics and associated sonar.

A graduate of Columbia University, Mr. Lapetina has had 12 years of experience with Sperry Gyroscope Co., and Edo Corp.

Lapetina

Marvin

Northern Electric appointments

New sales promotion manager of the wire and cable division of Northern Electric Co. Ltd. is **R. A. Marvin.** He succeeds the late M. R. MacDonald. Born in Edrans, Manitoba, Mr. Marvin graduated from the University of Manitoba with the degree of B.Sc. in electrical engineering. He joined the company in 1936.

(Continued on page 47)

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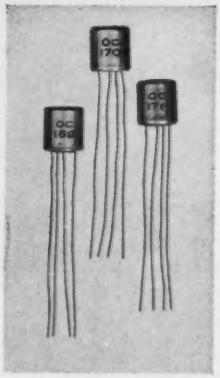
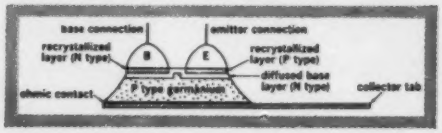


Here is the best value obtainable in db's gain per dollar for low noise—operation at low collector voltage, low collector to base capacitance—three new high gain V.H.F. transistors by Rogers. These high frequency transistors are ideal for such applications as:

- RF and IF amplifiers in production F.M. receivers
- As mixers, oscillators and RF and IF amplifiers in mobile radio equipment and short wave receivers
- For many applications in instrumentation and industry

How the Rogers V.H.F. Transistor Came to be.

A brand new alloy-diffusion process has been introduced by Rogers in which the best features of the currently used processes were combined, without their drawbacks. In the Rogers 'alloy-diffusion' process, alloying and diffusion take place simultaneously. The transistor is built up on a piece of germanium on which two small pellets are placed. When this assembly is heated at a certain temperature, the germanium dissolves into the metal pellets until saturation is reached and the pellet impurities diffused into the solid germanium. When this assembly is cooled down, a layer of germanium recrystallises from the pellets as in the normal alloy technique. This process makes it possible to mass produce transistors with a base layer of a few microns for very short transit time and high cut-off frequencies.



TECHNICAL DATA

MAXIMUM RATINGS		OC169	OC170	OC171
Vce		20 V	20 V	20 V
Ic		10 mA	10 mA	5 mA
Pc at Tamb. = 45°C		50 mW	60 mW	60 mW
TYPICAL CHARACTERISTICS				
Collector to base capacitance		—	1.8 pF	—
Unilateralised power gain	Pg at 0.45 Mc	66 db	57 db	—
	Pg at 10.7 Mc	27 db	31 db	—
	Pg at 100 Mc	—	—	23 db
Noise figure	NF at 0.45 Mc	4 db	4 db	—
	NF at 10.7 Mc	5 db	5 db	—
	NF at 100 Mc	—	—	11 db

For stability, uniformity and the best value in db's gain per dollar, use High Gain V.H.F. transistors by Rogers.

This reference sheet is one of a series from Rogers to keep you fully informed of electronic developments. A specially designed file folder for these bulletins is available from Rogers on request.

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Canadian Westinghouse gets order for F-104G electronics

Defence Production Minister Raymond O'Hurley recently announced the award of a contract to Canadian Westinghouse Company Ltd., Hamilton, for production of the Electronic Weapon Control System for the F-104G Starfighter.

The estimated value of the contract is more than $20 million, of which it is expected that 30% to 40% will be sub-contracted to other firms in the Canadian electronics industry.

Commenting on the award, Mr. G. L. Wilcox, president of Canadian Westinghouse said: "We are extremely pleased to be awarded prime responsibility for producing the equipment. The announcement was indeed welcome news for the many of our employees who would otherwise have faced layoffs. I have no doubt that our many suppliers of materials, components and sub-systems were equally pleased."

Three other Canadian companies entered bids, and the facilities of all four were appraised by officials of DDP and North American Aviation. The computer portion of the fire control system and possibly components of the antenna system will be sub-contracted.

Westinghouse plan to commence production immediately and expect to ship the first of the electronic units toward the end of 1960.

New Canadian company

Presentey Engineering Products Ltd., a Canadian-owned company, has been established at 1268 Henry Farm Drive, Ottawa. Standard products include a vhf antenna multicoupler, a phase generator and a multi-speed tape recorder. The recorder has been supplied to DOT for use in their fixed and mobile monitoring equipment. The company also offers consulting engineering services and engages in research and development in electronics, telecommunications, precision instrumentation and other fields of applied science.

President is S. Presentey, P.Eng., formerly senior research and consulting engineer with Canadian Marconi Co., Montreal. Mr. Presentey came to Canada in 1952 from France, where he held various electronics positions in industry and public service.

New Honeywell division

Honeywell Controls Ltd., Toronto has established an electronic data processing division. The new division will sell and service the company's transistorized data processing system under marketing manager P. J. Suddick.

Siemens Edison Swan executive tours Canada

Dr. J. N. Aldington, managing director of the Siemens Edison Swan group of companies, chairman of Submarine Cables Ltd., and executive director of Associated Electrical Industries Ltd., recently toured Canada. He was accompanied by H. T. Wormell, president of Siemens Edison Swan (Canada) Ltd. The Winnipeg firm is now a wholly-owned subsidiary of Associated Electrical Industries (Canada) Ltd., and has recently completed an 8,000 sq. ft. plant extension.

EDWARDS

Aldington

WARRANDER

Elder

New broadcast consulting service established

Canadian Design Service Co. Ltd., 119 Adelaide St. W., Toronto, has started a broadcast consulting service, with the approval of DOT. The new department is under the direction of J. Gordon Elder, formerly with Collins Radio Co. of Canada Ltd. and Sharpe Instruments Ltd.

CDS is active in the general field of communications engineering, drafting, writing, surveying and map making.

Marsland forms relay division

Marsland Engineering Ltd., Kitchener, Ont., has concluded an exclusive agreement with Filtors Inc., Port Washington, L.I., N.Y., to manufacture and sell in Canada the U. S. firm's complete line of hermetically sealed sub- and micro-miniature relays. Marsland has formed a new relay division at its Kitchener plant.

Firm expands to Vancouver

Kruger Associates Ltd., manufacturers' representatives, has recently expanded its coverage to include British Columbia and has located its new Vancouver offices at 119 West Pender St. Head office remains at 166 Princess St., Winnipeg. Martin N. Kruger has been appointed vice-president and sales manager, Pacific division. Gordon M. Kruger is president and sales manager, Prairie division.

International Rectifier seeks distributors

International Rectifier of Canada Ltd. wish to appoint distributors for all territories across Canada. Full details may be obtained from Mr. E. F. Johnson at 1581 Bank St., Ottawa.

Electronic multiplex course arranged by DOT

Fourteen experienced Department of Transport radio engineers and technicians have just completed the first formal course on Elmux, the new Siemens and Halske transistorized error correction equipment for radio teletype communications, which is to be installed on DOT circuits.

The course, which also included engineers from DND, was sponsored by DOT and arranged by The Ahearn and Soper Co. Ltd., Canadian representatives of the manufacturers.

(Continued on page 47)

WARRANDER

J. R. Foster of The Ahearn and Soper Co. Ltd. explains the 7-unit code principle of Elmux to E. F. Porter, E. T. English and J. R. MacKay of DOT.

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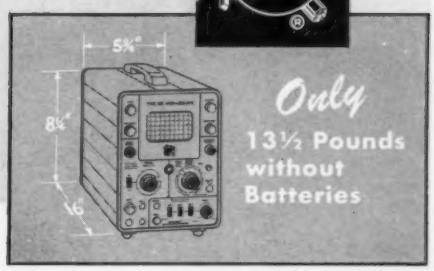

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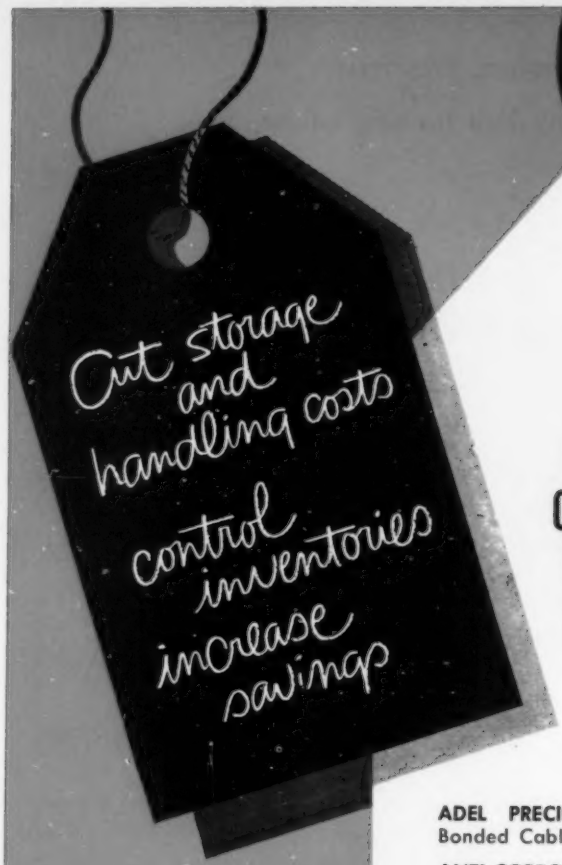

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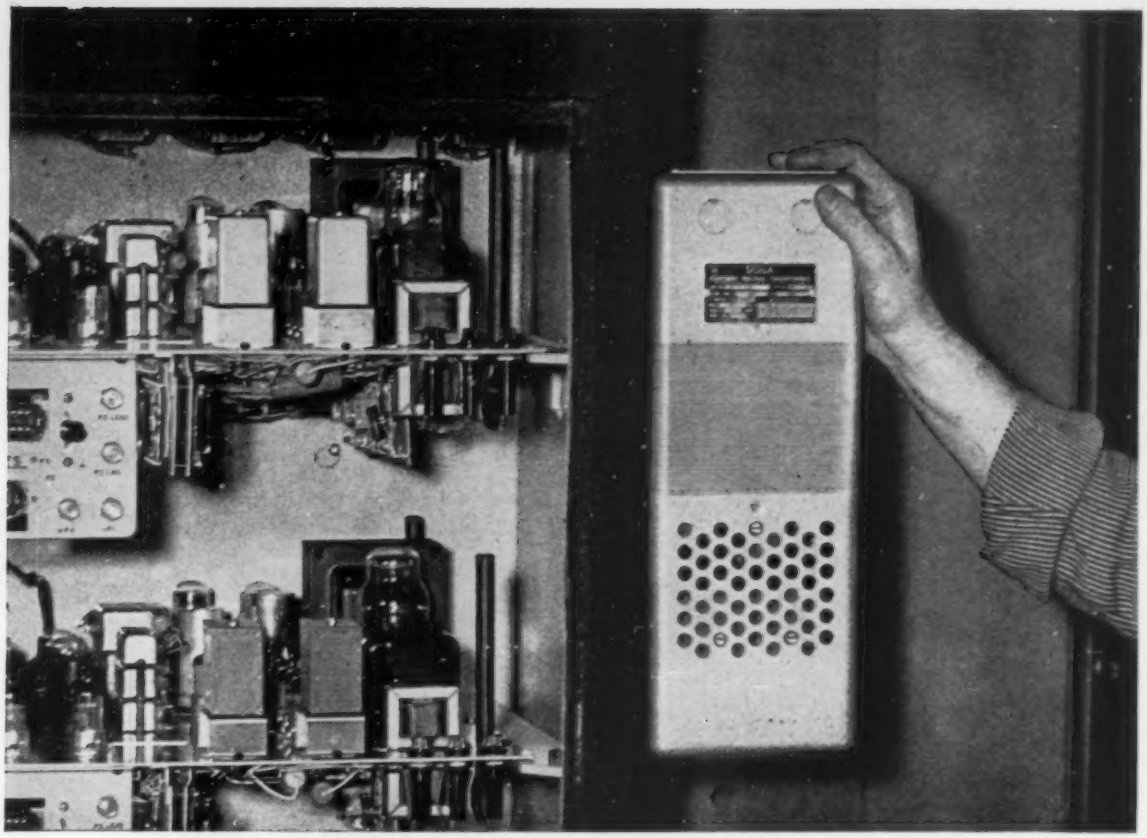

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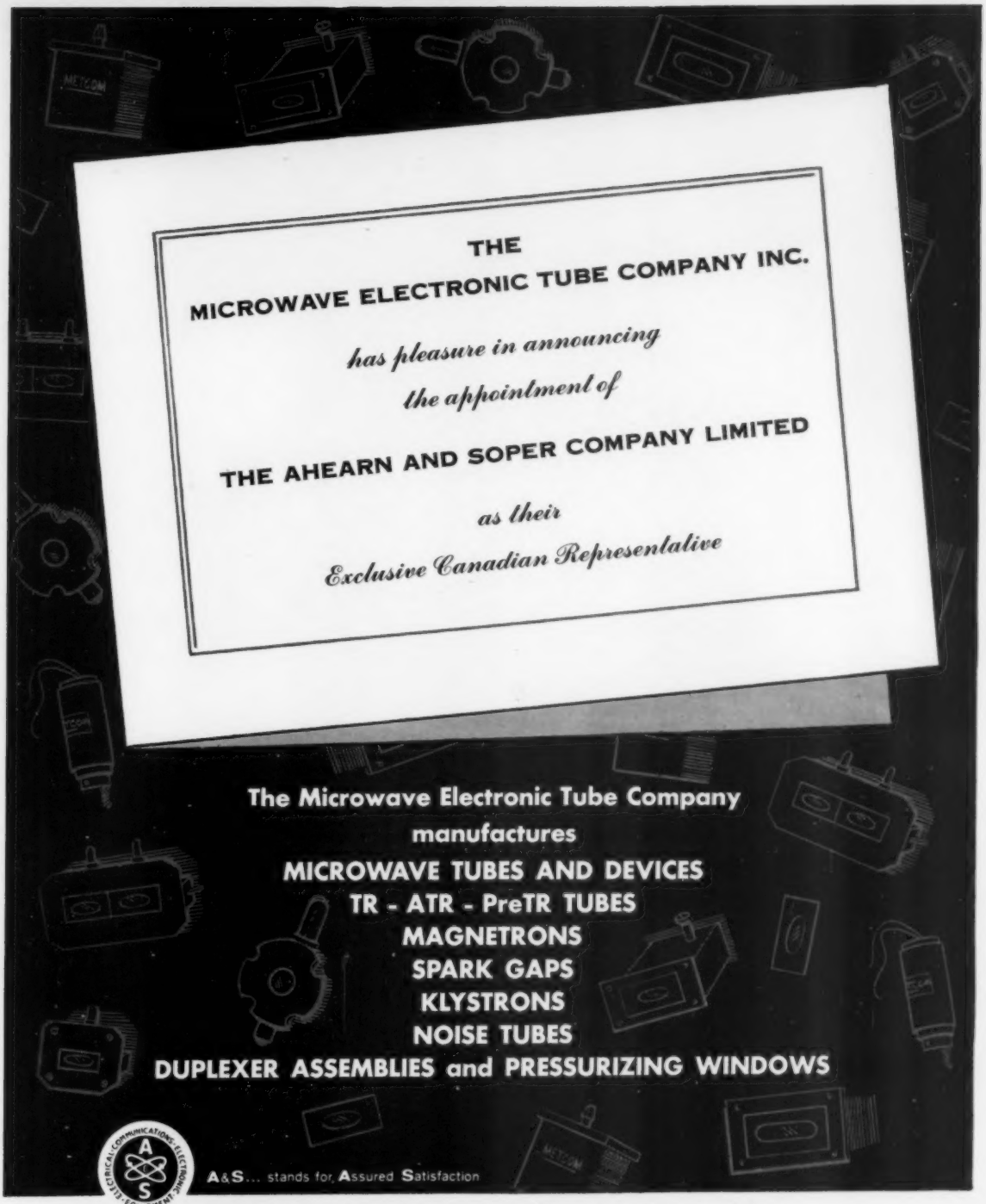

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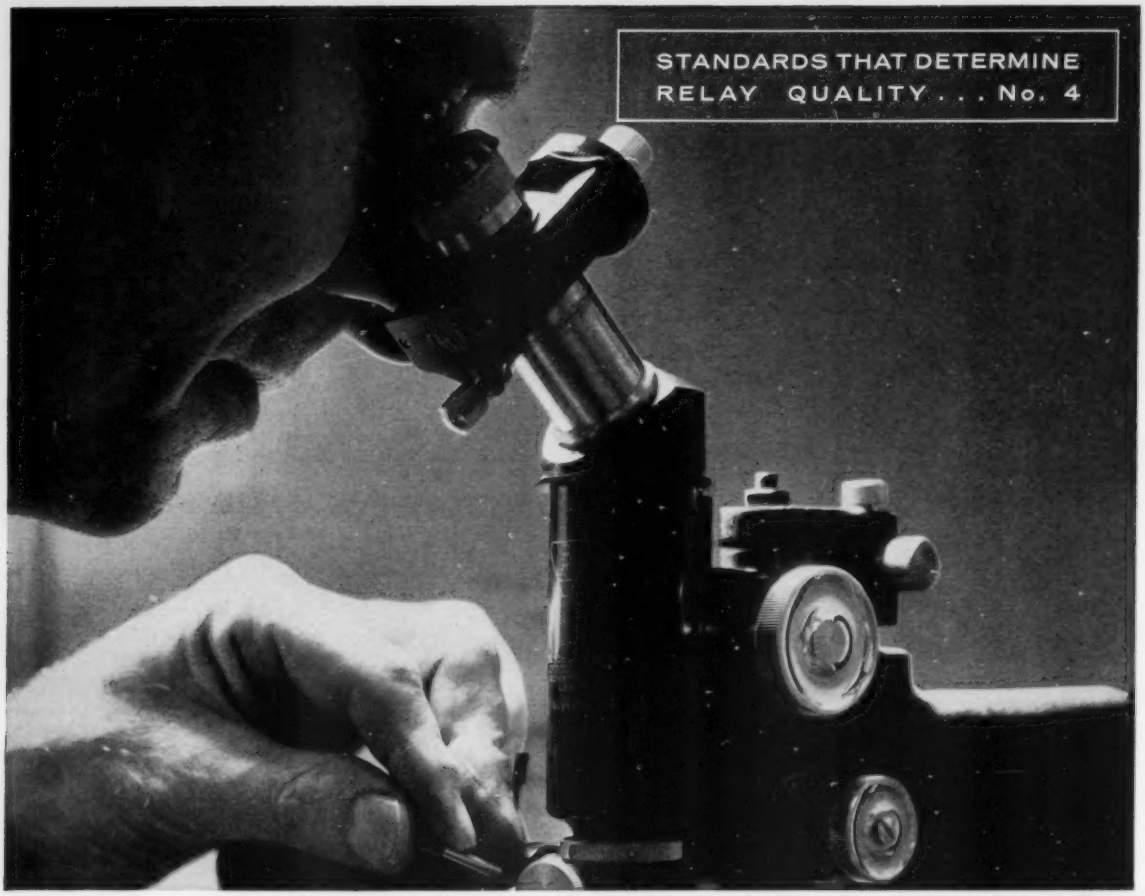

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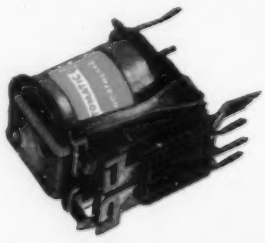

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Electronics engineers can work for peace

Donald B. Sinclair, vice-president of The Institute of Radio Engineers, officially opened the 1959 IRE Canadian Convention. We think that his address is worthy of repetition; the salient passages follow.

". . . the keynote of this convention could well be the growth of internationalism, in keeping with the world-wide nature of radio communication. Starting as a very local venture in 1912, with a handful of members recruited from Boston and New York, the IRE has grown today to an international society of 75,000 members with sections not only in Canada and the United States but in Argentine, Brazil, Colombia, Israel, Egypt, Benelux, Italy and Japan.

"Canada's progress in international status has run a parallel course. Not so many years ago a Dominion, Canada now takes its place not only as an equal partner in the British Commonwealth of Nations but, progressively, as a stronger and stronger voice in the United Nations and an important force in international trade.

"The exposition here displayed, which accompanies a predominently Canadian program, has an international flavor that illustrates the point. And not only the coastal cities are now directly involved in foreign shipping since the St. Lawrence Seaway has brought the world's ocean-going vessels to the heart of the continent.

"With trade comes individual contact and with contact comes understanding. As a showcase of Canada's scientific progress and, at the same time, of the world's commercial developments, the IRE Canadian Convention can perform yeoman service both in strengthening domestic professional development and promoting international trade.

"The IRE Board of Directors, in recognition of the nature of this meeting, has scheduled an extra day's discussion of the international aspects of the institute's activities. At a time when the military importance of electronics is so clearly evident it is heartening to remember that along with national desires for the safety and strength to be found in an arsenal of modern weapons there runs a strong counter interest supranational in character, in the inherent truth that is to be found in pure science.

"There is, fortunately, a certain amount of this nobler element in all technical people. I have already had the opportunity to visit scientific institutes in the Soviet Union and attend papers delivered at technical meetings there.

"Next month I expect to be at a meeting in Hungary on microwave communications. It has been my experience that enquirers at these institutions and meetings tend to think and act very much as we do. It is too much to hope that this means that exchanges of visits and information among engineers and scientists will end the cold war, but it is important that every effort be made to see what can be accomplished and the IRE is actively co-operating with the U.S. State Department in promoting such exchanges . . ."

THE EDITOR

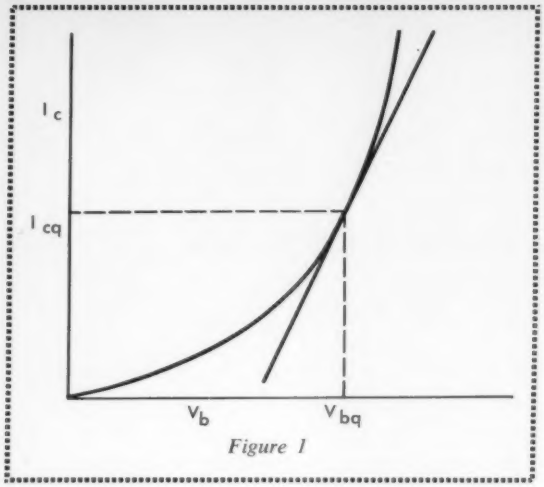

Figure 1

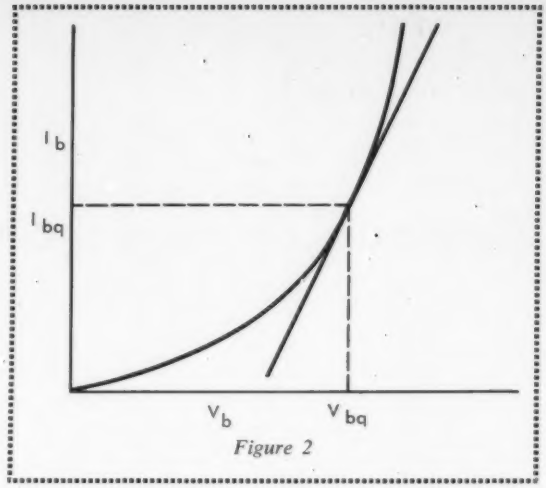

Figure 2

How to design transistor power amplifiers

H. L. ARMSTRONG*

Step-by-step design methods are presented for several different transistor power amplifier circuits. These include Class A single transistor, transformer-coupled, also direct-coupled resistive load; Class A transformer-coupled push-pull; and Class B push-pull.

In a previous article,[1] some drastically simplified methods for the design of transistor amplifier stages were discussed. The considerations there applied chiefly to low-level stages, where shifting of the operating point with changes in temperature is one of the biggest problems. The present article will deal with power amplifier stages, in which other problems are encountered.

Although there are more problems to be overcome, usually there will be more information available about a power transistor. As well as the usual family of output characteristics (I_c vs. V_c, with I_b as a parameter) other curves will often be available. In particular, there will often be curves of I_c vs. I_b, and I_c vs. V_b. In this treatment, the last is of especial importance, for reasons that will become clear later. Both these curves should have V_c as a parameter, but often the effect of V_c on these characteristics will be so small that one could pick one "mean" curve, which would apply quite well over a range of values of V_c. Note that all these voltages are referred to the emitter.

The curve of I_c vs. V_b might be as shown in Fig. 1. The slope of this curve at the operating point (I_{cq}, V_{bq}) might be called the transconductance of the transistor. The other thing which one would want to know is the input conductance of the transistor. The input conductance can be found by dividing the transconductance by h_{21} (or "beta"), the current gain of the transistor, since $I_b \approx I_c/h_{21}$.

Of course, a curve of I_b vs. V_b may be available, then its slope at the operating point gives the input conductance directly, as shown in Fig. 2.

It will seldom be necessary to determine the output conductance, since the load will ordinarily represent a much larger conductance in parallel with it. Thus the effects of output conductance are negligible.

Now that these preliminary remarks have been made, the design of several different kinds of amplifier stage will be considered. The bias voltages and currents, it is to be noted, will be written as positive

*Department of Physics, Queen's University, Kingston, Ontario.

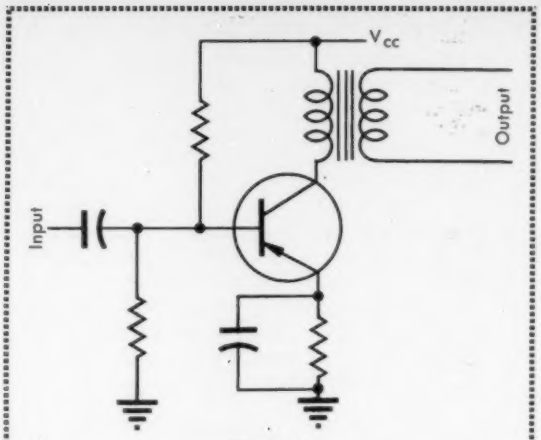

Figure 3

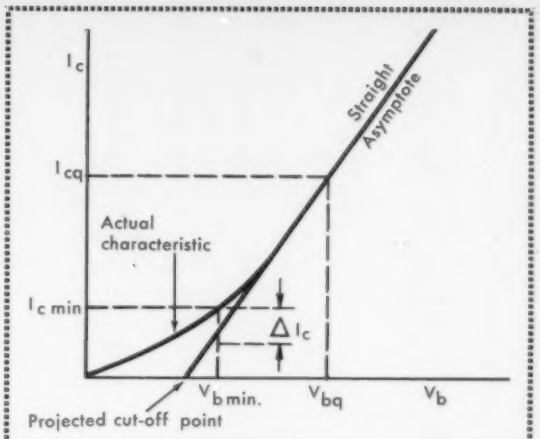

Figure 4

quantities for generality; the actual sign, of course, depends on the type of transistor used, whether p-n-p or n-p-n.

Class A, single transistor, transformer coupled

The circuit is shown in Fig. 3. Note again that all voltages are referred to the emitter.

a. The desired output power will usually be specified. If the operating point is at V_{cq} and I_{cq}, the power supplied to the transistor will be $V_{cq}I_{cq}$. A class A amplifier can not possibly be more than 50% efficient; thus the absolute maximum output power would be $V_{cq}I_{cq}/2$. However, this can not be attained without severe distortion.

b. Thus, choose a transistor for which values of V_{cq} and I_{cq} giving $V_{cq}I_{cq}$ equal to somewhat more than twice the desired output power are allowable. Ordinarily $V_{cq} \approx V_{cc}$, and V_{cc} is often specified. The peak voltage applied to the transistor will be about 2 V_{cq}; check to make sure that this is within the allowable limits of collector voltage.

c. Often the maximum allowable distortion will be specified. To check on that, proceed as follows. Usually, the I_c vs. V_b characteristic of the transistor will be of the form shown in Fig. 4. The curve usually approaches a straight asymptote, as shown.[2] If this asymptote were the characteristic, there would be no distortion at all. Actually, however, at the lowest swing of the base voltage, where $V_b = V_{b\,min.}$, the collector current will differ from the "linear value" (i.e., the value it would have if the straight asymptote were the actual characteristic), by an amount ΔI_c, as shown. The actual collector current, for $V_b = V_{b\,min.}$ is $I_{c\,min.}$. The distortion is roughly

$$\% \text{ Distortion} \approx \frac{\Delta I_c}{2(I_{cq} - I_{c\,min.} + \Delta I_c)} \times 100 \quad (1)$$

Also, provided that I_c, and hence the distortion, is not too large, the output power, P_{out}, is given by

$$P_{out} \approx \frac{1}{2} V_{cq}(I_{cq} - I_{c\,min.} + \Delta I_c) \quad . \quad . \quad (2)$$

Thus

$$\% \text{ Distortion} \approx \frac{V_{cq}\,\Delta I_c}{4\,P_{out}} \times 100 \quad . \quad . \quad . \quad . \quad (3)$$

If P_{out} and the maximum allowable distortion are specified and V_{cq} has been chosen, this will give the maximum allowable value of ΔI_c.

d. On the I_c vs. V_b curve find the value of V_b at which the value of ΔI_c (which, of course, is just the vertical distance between the asymptote and the actual characteristic) is equal to the value found in part *c*. This will be at the actual working value of $V_{b\,min.}$ and the characteristic will give the corresponding working value of $I_{c\,min.}$. Then equation (2) could be re-written

$$I_{cq} = I_{c\,min.} - \Delta I_c + \frac{2\,P_{out}}{V_{cq}} \quad . \quad . \quad . \quad . \quad (4)$$

Thus the value of I_{cq} to fulfill specifications for both power output and distortion is found.

e. Check to ensure that the finally chosen value of I_{cq}, along with that of V_{cq}, still gives an allowable operating point for the transistor. Usually it will; if not, another transistor type will have to be chosen.

f. Choose a load resistance of magnitude such that, for the maximum value of I_c, the value of V_c will be reduced to say one volt, or whatever seems to be the smallest value possible without causing the I_c vs. V_b characteristic to depart much from the assumed value.

g. The operating point at $I_c = I_{cq}$, $V_c = V_{cq}$, and $V_b = V_{bq}$ is now known. It is desirable also to know I_{bq}'—this may be found from the I_b vs. V_b characteristic, if available; otherwise by dividing

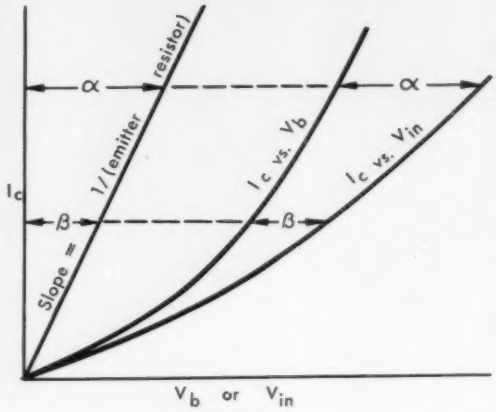

Figure 5

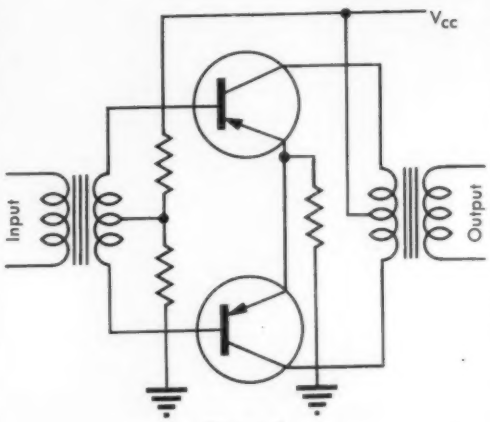

Figure 6

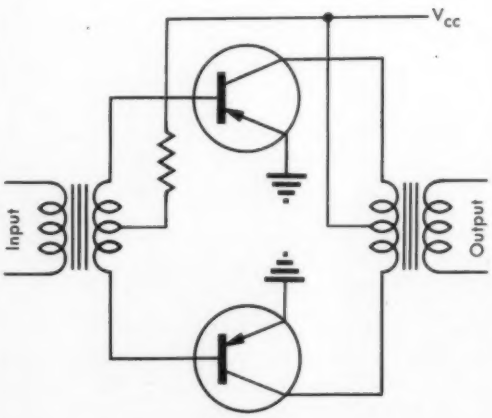

Figure 7

I_{cq} by the base-to-collector current gain h_{21} or beta. Now design the stage for operation at the chosen point by one of the methods suggested in the previous article. Sometimes temperature effects will not be of any importance, since I_{bq} will be much greater than I_{cbo}, the collector-to-base leakage current. Remember that r_L, as it enters into consideration of the operating point, will be just the d-c resistance of the transformer primary, and will often be quite negligible.

If temperature effects need to be considered, remember that the internal temperature of the transistor may be considerably higher than the ambient temperature. The ratio of temperature rise to power dissipation in the transistor is usually called the "thermal resistance" in degrees per watt; and this information if often provided.

h. If there is an unbypassed emitter resistor, the voltage across it must be added to V_b to indicate the input voltage necessary for a given collector current. This may be done as shown in Fig. 5. A straight line whose slope is the reciprocal of the emitter resistance, is drawn, and this line and the characteristic are added to give an "effective" characteristic.

Class A, direct-coupled resistance load

About the only reason for using such an arrangement would be that one had some resistive device to be driven. Thus, the load resistance would be specified in advance. Since $V_{cq} \approx V_{cc}/2$, and $I_{cq} \approx V_{cq}/r_L$, it is possible to choose independently only two of V_{cc}, r_L, and P_{out}. Once the choice has been made, the design may proceed as above.

Class A, transformer-coupled, push-pull

A possible circuit is shown in Fig. 6. Note that, because of the push-pull feature, it is possible to fasten the two emitters together, using one common unbypassed emitter resistor, and this arrangement introduces no negative feedback. Similarly, the transistors may be driven from a transformer with a centre-tapped secondary, and the circuitry is simplified (i.e., a capacitor eliminated), by applying the bias at the centre tap, as shown.

The actual design, in choice of bias and operating points, may go just as it did for the single transformer-coupled transistor. Remember that the load resistance will be twice that for one transistor.

Class B, push-pull

There are several possible choices of operating point; here the operation will be around the "projected cut-off" point, and the design procedure will use the idea of a "composite characteristic." This design is economical of battery power (and this economy is the usual reason for going to class B operation), and at the same time leads to reasonably low distortion. Fig. 7 shows an arrangement for class B operation.

In Fig. 4 is shown what is meant by the "projected cut-off point." It is the intercept of the straight line, to which the characteristic is asymptotic, on the V_b axis.

Fig. 8 illustrates the idea of a "composite characteristic." Consider the two (presumably identical) characteristics, the one turned through 180° and the two arranged together so that their projected cut-off points coincide. The composite characteristic, shown dashed, is found just by adding the two characteristics in this position. As is seen, it approaches the asymptote at each end (i.e., for large currents in one transistor, small or zero in the other), while around the centre it follows the curve which was found by (probably graphical) addition of the two characteristics.

Now that these preliminaries are finished, the actual design will be considered.

a. Usually the desired output power will be specified. One might assume that the circuit will be about 60% efficient, so that power equal to 2/3 the output power will have to be dissipated in the two transistors. Thus choose a transistor whose maximum power rating is at least $P_{out}/3$.

b. Often, because of practical considerations, V_{cc} will be known in advance; if so, make sure that the transistor chosen can stand at least $2V_{cc}$ on the collector. If V_{cc} is not specified, choose a value such that $2V_{cc}$ is within the allowable range of collector voltages for the transistor being considered.

c. Let the maximum collector current in each transistor be I_{cm}; then $P_{out} \approx I_{cm}V_{cc}/2$. If V_{cc} has been chosen, this relation will serve to determine I_{cm}. Once I_{cm} is known, the necessary input signal is, of course, found directly from the characteristic.

d. The load resistance collector-to-collector (i.e., between the two ends of the primary of the output transformer) will be enough that, for a current I_{cm}, the collector voltage is reduced to say one volt. This would make $r_L = 4(V_{cc} - 1)/I_{cm}$. (Here, as in other class B circuits, the factor 4 enters, of course, because the current from one transistor actually flows through only half of the primary.)

e. The distortion may be estimated as follows. Find ΔI_c, the greatest amount by which the composite characteristic deviates from the straight line. The percent distortion will be roughly $(\Delta I_c/I_{cm}) \times 100$.

f. The requirements for temperature stabilization are a little different here. What is desired is that, under changes in temperature, the operating point continue to be given by the projected cut off, i.e., that V_{bq} continue to be equal to the intercept of the asymptote on the V_b axis. But this intercept is a function of temperature; in general, it decreases more or less linearly with increasing temperature. The value of the intercept at normal temperature will be chosen as V_{bq}, the value of V_b at the nominal operating point, and I_{cq} may be found from the characteristics. Now choose for V_{bz}, the base bias voltage at the extreme operating point, the value of the intercept at the maximum anticipated temperature. (If information is available about only one temperature, it is reasonable to assume that the intercept voltage will decrease about 0.002 volt for every degree C increase in temperature[3].)

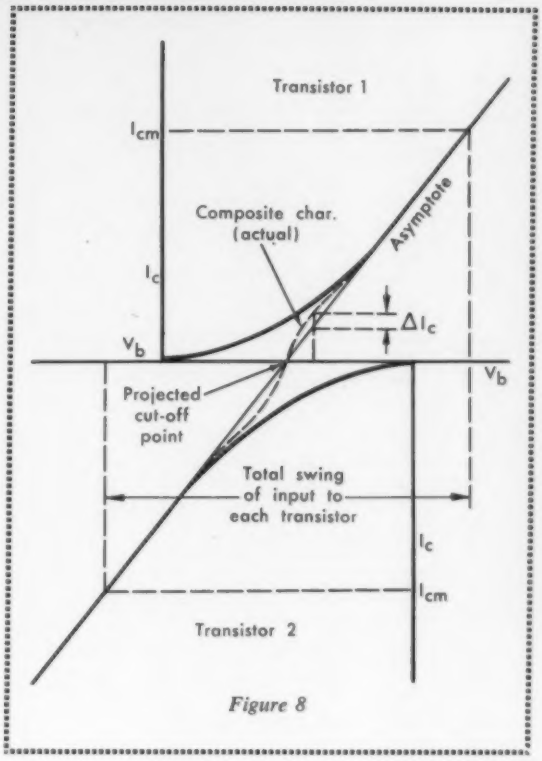

Figure 8

The nominal and extreme operating points (or, at least, the currents at these points), having been chosen, complete the design in the way described in the first article.

g. Ordinarily, the base current corresponding to the projected cut-off point varies less with temperature than does the voltage. Accordingly, it may be satisfactory to use fixed base bias current. If it is desired to try this, the simplest thing is just to set up the desired operating point and then investigate, as much as possible with whatever information may be available, what effect temperature changes will have.

h. If there is an unbypassed emitter resistor (and for class B operation an emitter resistor should be unbypassed), its effect may be investigated in the way described in part *h* of the method for the single-transistor circuit. END

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1. How to design transistor amplifiers, by H. L. Armstrong, CEE, p. 29, April 1959.

2. H. L. Armstrong, Proc. IRE 47, 83, 1959.

3. H. L. Armstrong, E. D. Metz, and I. Weiman, IRE Trans. PGED vol. 3, p. 86, April 1956; the authors show reasons which might help to explain this behaviour. (The pertinent part is about pp. 90-91, and the discussion is concerned with Fig. 6. Note that $I_n T$ is approximately constant, and about equal to $I_n 300$.)

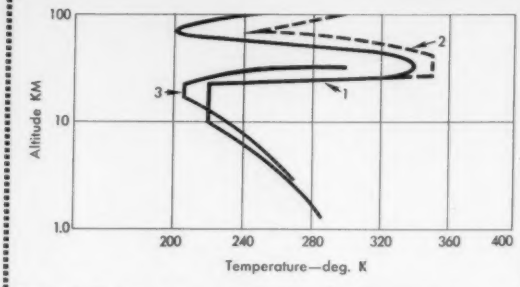

Fig. 4. Temperature estimates and measurements

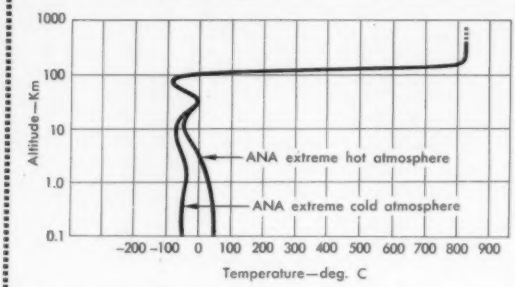

Fig. 5. Temperature variation with altitude

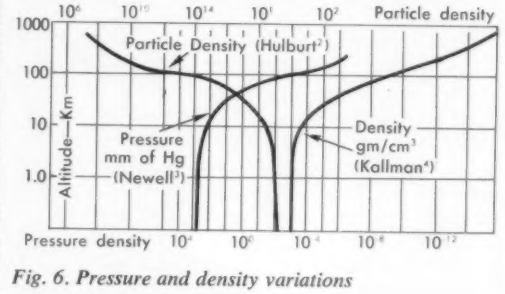

Fig. 6. Pressure and density variations

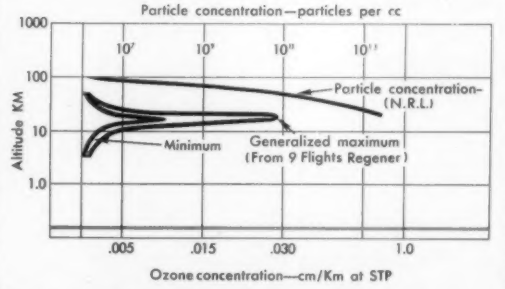

Fig. 7. Vertical distribution of ozone

What's up there?

A summary of latest data on earth's environments up to 1000 kilometres

A. P. HARRIS, P.ENG. & E. W. PARROTT, P.ENG.*

PART 2: Continuation of "Gases" and "Fields, Radiant Energy and Particles." Part 1 of this paper was published in CEE October, 1959, pages 44-47.

Temperature

Both earth surface temperatures and air temperatures up to the limit of atmosphere are direct functions of the amount of solar radiation received by the earth. The temperature varies daily, seasonally and with geographic location, due to the earth's rotation, its angle of inclination, and its distance from the sun. There is a complex phenomenon, involving absorption and radiation effects of the earth and the various constituents of the atmosphere which largely determines the temperature at any given place and time.

Surface temperatures over the earth have reached extremes as low as minus 79 C (—102.2 F) and as high as 60 C (+140 F). It is convenient to divide the earth's surface into four general areas according to their climate and for these areas representative mean temperatures are as follows:

Polar	5 C
Temperate	25 C
Tropical	32 C
Desert	40 C

Typical daily and seasonal variations in this area are as follows:

	Daily Variation	Seasonal Variation
Polar	—	83 C
Temperate	11 C	32 C
Tropical	1.6 C	17 C
Desert	17 C	45 C

These are surface temperatures and changes in temperatures with increasing altitude are shown in fig. 4.

These curves are a few of the many measurements and theoretical calculations which have been made of temperature in the upper atmosphere. While they disagree in magnitude they have a common shape and a common theory is accepted for the reversals in temperature.

At low levels the air picks up heat by actual contact with the warm earth surface and by long wave or infrared radiation from the earth. This radiated energy is absorbed by carbon dioxide, ozone and water vapor but is almost immediately reradiated. Below about 20 Km the energy lost by reradiation is greater than the energy absorbed and there is a steady drop in temperature of about 6.5 C for each Km rise. This is varied by local weather conditions and the geographic location. The rate of decrease is more rapid at the equator than at the poles

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due to different humidity conditions. The first change in direction is explained by the absorption of solar energy by ozone at ultraviolet wavelengths.

This energy is emitted at a higher altitude, depending on the carbon dioxide and ozone present, resulting in a temperature peak at about 50 Km. The energy at ultraviolet wavelengths absorbed by ozone, above its peak concentration, is greater than the energy radiated at infrared wavelengths by water and carbon dioxide.

As the ozone concentration decreases the energy radiated exceeds the intake and the temperature drops again to a low at about 80 Km.

Above 80 Km dissociation of gas molecules and ionization occurs, increasing the number of particles, and making the air conducting. Thus a large amount of solar radiation is absorbed and the temperature increases rapidly with height.

The tolerances on this curve, which depend on geography, etc., can be simplified and fig. 5 is a proposal to this end.

The two "legs" are the ANA Standard extreme hot and cold atmospheres, trimmed off at about 40 Km.

The succeeding upper portions of the curve cover both the proposed WADC standard atmosphere to about 70 Km, and the latest known NRL theory above this point. The curve above 70 Km assumes certain conditions, including a certain composition of the atmosphere, dissociation of oxygen and nitrogen and certain particle densities.

The curve shown represents average temperatures on which there are daily and seasonal changes. Above 500 Km the "temperature" probably drops to nearly absolute zero at night when shielded from the sun's radiation.

Starting about 80 Km the temperatures shown have not the same significance that the environmental engineer is normally used to. The air density and the number of particles present becomes so low that heat conduction and convection do not apply. The temperatures are without real heat and are representative of the velocities of the air particles.

The temperature of objects placed in space above this level is determined almost solely by the energy of the solar radiation received, the type of surface and the balance between absorption and reradiation.

Pressure and density

The pressure in millimetres of mercury, the density in grams per cubic centimeter and the actual number of particles present are shown in fig. 6.

The actual number of particles present at 100 Km is about one millionth of that at sea level.

This means, in more practical terms, that normal breathing becomes impossible after 16 Km, fuels will not burn after 21 Km, aerodynamic lift is lost between 80 and 110 Km and thermal problems and ram air effects largely disappear between 160 and 180 Km.

It may be of interest to note that the pressure at 250 Km is about the same as that in an evacuated electron tube.

Ozone

Molecular oxygen is dissociated to atomic oxygen by the action of ultraviolet radiation. Atomic oxygen combines with molecular oxygen in the presence of another air particle to form ozone O_3.

The distribution of ozone with height is shown in fig. 7.

The units here are centimeters per kilometer, or the equivalent thickness, in centimeters, of ozone in a kilometer of atmosphere when the ozone is compressed at normal pressure and zero degrees centigrade.

The peak occurs at about 21 Km. The two curves are representative of the maximum and minimum concentrations and encompass the results of a particular series of measurements.

The altitude of peak occurrence is not constant and varies with the season of the year between 17 and 24 Km, being highest during the winter months.

The actual particle concentration deduced is shown in the top curve and varies from about 5×10^8 particles per cc at 90 Km to about 8×10^{12} particles per cc at 30 Km.

At sea level the ozone concentration is very small and in the order of .001 cm per Km, and a daily variation in this concentration as high as 6 to 1 occurs.

Ozone has some interesting properties. It is highly absorptive to high frequency sunlight and in fact cuts off from the earth most radiation less than 2,550 Angstrom units. A reduction in the total atmospheric ozone by 1/3 would cause blistering of human skin. If doubled, one of the controlling factors in formation of bacteria and fungi would be lost. Ozone concentrations of the value occurring at 21 Km are toxic.

Moisture vapor

Moisture vapor, the gaseous form of water which forms over bodies of water, is a common constituent of the atmosphere over most of the earth's surface.

The ability of the air to hold moisture depends directly on its temperature. This ability doubles with every 10 C increase in temperature. Because of this, the absolute humidity, which is the weight of actual vapor in a given volume of air, is greatest in warm climates and lowest in cold. The arctic, not the desert, is the driest area in the world.

Extremes of absolute humidity have been measured from about 50 grams per cubic meter, in hot coastal areas near the equator, to less than .001 grams per cubic meter in polar regions. Standards have been proposed as average values for various conditions and we have chosen the following:

Temperate Area	11.5 gms/meter^3
Tropical	27.5 gms/meter^3
Polar	.02 gms/meter^3
Desert	4.4 gms/meter^3

As there are daily and seasonal variations with temperature on all areas of the earth's surface, so there are daily and seasonal variations in absolute humidity.

The amount of water vapor in the air decreases rapidly with altitude and above 10 Km is extremely small. Fig. 8 shows measurements made to 30 Km in a temperate zone. You will see that the absolute humidity has dropped from about 12 gms/m^3 at sea level to .1 at 7 Km. In these measurements no value exceeded .05 gms/m^3 from 7 to 30 Km, and was about .0025 gms at 30 Km. It has been stated that the absolute humidity remains constant at about .002 gms/m^3 above the tropopause (20 Km).

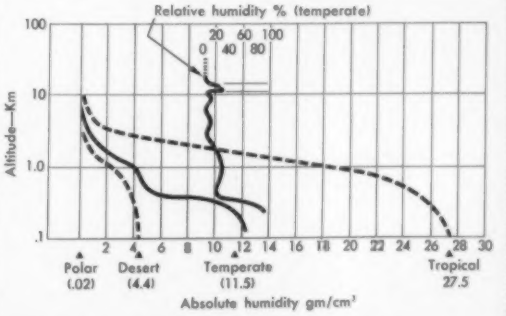

Fig. 8. Vertical distribution of water vapour

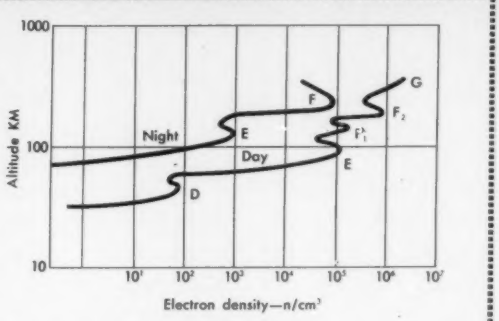

Fig. 9. Electron density versus altitude

On this graph are shown the mean values previously mentioned. The dotted lines show the probable distribution of water vapor with altitude above these various areas, all reducing to about .001 gms at about 10 Km.

Comparison with the temperature curve will show possibilities of saturation and, in fact, two positions where the relative humidity reaches 100% are at 12.7 and 16.3 Km.

The corresponding curve of relative humidity is shown. It is below 4% between 20 and 30 Km.

With the higher temperatures around 50 Km and above 100 Km it might be assumed that higher values of absolute humidity might exist. These areas are, however, far removed from water sources and the moist rising air must pass through temperature inversion regions at lower altitudes, which would dry out the air by condensation.

There is water vapor present, however, up to 100 Km or more and this small amount of vapor is important, along with carbon dioxide, in reradiating energy in the infrared region thus affecting the heat balance and temperatures in the upper atmosphere. It also influences, directly and indirectly, the amount of visible solar radiation reaching the earth and has a dispersive and absorptive effect on other electromagnetic radiation.

Ionized layers

Solar radiation of wavelengths less than 3000A produces ionization of the molecules of the gases of the upper atmosphere.

The most important effect of this ionization lies in the distribution of the electrons which give rise to the well-known ionized layers. These layers, called the D, E, F^1, F^2 and G layers, are illustrated in fig. 9.

The so-called layers are not actual layers of ionized particles but rather regions where the gradient of virtual height against electron density becomes steep.

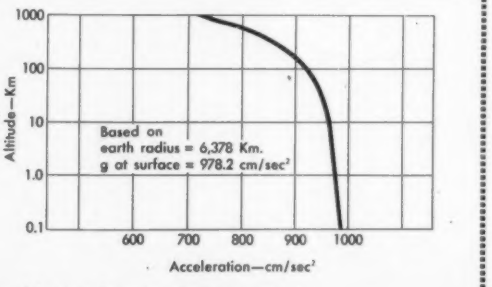

Fig. 10. Acceleration due to gravity

In addition to the easily recognized layers further cloud-like accumulations of ionized molecules exist called Sporadic E. These occur at heights between 75 and 110 Km and are believed to be formed by the passage of meteors which leave ionized trails as mentioned earlier.

Wind

Much has been published on winds on a statistical basis and as they are influenced so greatly by local conditions a complete picture cannot be attempted here.

The basic mechanism of the winds at altitudes below 80 Km lies in the convection currents caused by the rise of warm air in the equatorial regions, the resulting flow of cold air from the polar regions and the effect of the Earth's rotation on this process. The earth's rotation causes air masses to move at right angles to the pressure gradient. Thus the replacing of air at the equator does not take place by a simple wind from the poles but rather by a slow-moving mass of air, with its associated turbulences that cause the local weather conditions.

In general the wind speed can be assumed to vary as the square root of logarithm of altitude. Wind velocities up to 800 Km per hour (500 mph) have been recorded at ground level at the centre of tornadoes and upward winds of 480 to 720 Km per hour (300 — 450 mph) have also been noted.

Between 9 and 14 Km high are the jet streams, elliptical in section and traveling from west to east at speeds up to 480 Km per hour (300 mph).

The pressure exerted by a wind is proportional to the square of the speed.

Acoustic noise

The only natural acoustic noises of sufficient magnitude to constitute an environment originate from lightning (about 100 db), exploding meteors, and possibly winds.

The pressure from these sounds is related to their velocity, which in turn is related to the ratio of the specific heats and the gas constant, the absolute temperature and the molecular weight.

This relationship holds to about 120 Km. Above this the mean free path of the molecules becomes comparable with the wavelength of sound and the velocity has little meaning.

Meteors exploding above altitudes of 50 Km are not heard at the surface of the earth as temperature inversions refract the sound wave, and the magnitude of the pressure waves is correspondingly unknown.

FIELDS, RADIANT ENERGY AND PARTICLES

We have already seen some of the relationships between the electrical environments and the physical environments, and the field, radiant energy and particle environments are now considered in more detail.

Gravity

Gravity is an often overlooked environment, and of general interest is the variation of the force of gravity with altitudes.

At the altitudes we are considering this variation may become appreciable and fig. 10 shows the variation in acceleration due to gravity up to 1,000 Km from the earth's surface. This curve is based on figures for the earth's radius and acceleration, due to gravity, which are shown on the graph.

It is self-evident that gravity is a controlling factor in all the environments we have discussed to date.

Local variations depend on the nature and density of the earth's crust at the point of measurement. There are minute daily and seasonal variations dependent on the relative positions of the sun, moon and earth.

Magnetic fields

Like most solid magnets, the main portion of the earth's magnetic field is within the earth itself. The seasonal fluctuations of this field are attributed to the electronic current systems which flow in the ionized portion of the atmosphere between 70 and 450 Km.

Any movement of electrons in these layers constitutes an electric current which produces an associated magnetic field. These fields, which are most intense over the polar areas, interact with the regular earth's field producing innumerable variations in magnetic measurements.

The earth's field varies inversely as the cube of the distance from the axis and at 90 Km has decreased about 5%.

The changes in the earth's field are related to the aurora, the ionized layers, changes in cosmic ray intensity and weather patterns including rainstorms and high-pressure areas.

Electrostatic fields

Atmospheric gas is ionized by radioactivity from the earth, radioactive substances in the air, and cosmic rays. These ions make the air conducting and also constitute a space charge.

The total charge on the earth, in combination with local charges caused by clouds, rain, dust and wind, causes a potential difference with altitude near the surface of the earth.

This potential increases with altitude at the rate of about 100 volts per meter in good weather. This will vary with time as the amount of atmospheric pollution and winds vary. Over the oceans, where pollution is small, the variation is small, about ±10 to 15%. Mean values at different locations on the earth vary from 30 to 240 volts per meter.

Fig. 11 indicates the change of potential with altitude.

The rate of increase of potential decreases rapidly. At 5 Km it is about 1/10 of the surface value and at 10 Km about 1/50.

During weather disturbances, sporadic local charges occur. 5,000 to 10,000 volts per meter may occur in continuous rain, 10,000 volts per meter in thunderstorms. The field may change from positive to negative and back again for small periods.

At about 30,000 volts per meter, discharge in the form of lightning or corona may take place.

Lightning involves current flows as high as 300,000 amperes but on an average about 15,000 amperes, the current peaks lasting 20 to 1,000 microseconds. This release of energy causes local radio interference or noise and "whistlers" or wide-range interference.

Electromagnetic fields—general

The atmosphere is penetrated by a tremendous number of waves of energy originating from the earth and from space, and these are distributed throughout the complete electromagnetic spectrum.

Excluding man-made sources, the sun is the principal source of natural electromagnetic radiation, producing nearly all wavelengths.

Other bodies, far distant in space, are sources of continuous radiation in the wavelengths we use for communication as well as in the visible light range.

Unwanted transient bursts of energy, or noise, also have earth and space origins.

Solar radiation

The sun is the direct source of most of the environments which concern us. The energy spectrum of the radiation has been established as being composed of all wavelengths down to at least 7A and possibly beyond.

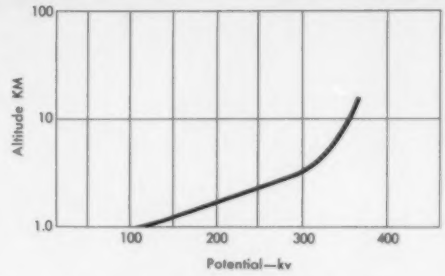

Fig. 11. Solar radiation at edge of atmosphere

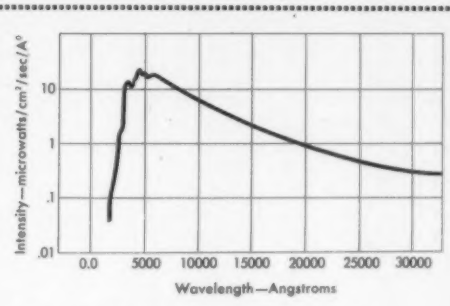

Fig. 12. Potential versus altitude

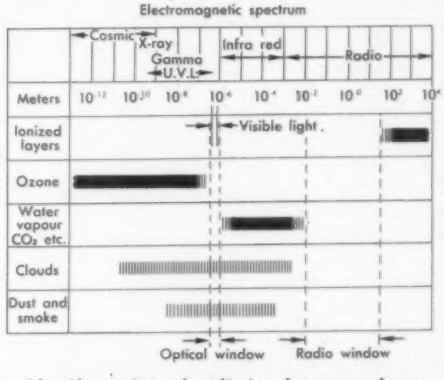

Fig. 13. Absorption of radiation by atmosphere

The total energy arriving on a plane surface, normal to the sun, at the edge of the earth's atmosphere is practically constant at 1.94 calories per square centimeter per minute when the earth is at its mean distance from the sun. Variations of 1 to 2% have been recorded and the spectrum below 30,000A is shown in fig. 12.

Of this total energy only 40% reaches the earth and this energy does not have the same spectral distribution as that on the edge of the atmosphere. Selective absorption of the solar energy takes place in its passage through the atmosphere resulting in the concept that the atmosphere has two "windows" to space, an "optical window" and a "radio window". The former allows transmission in the

band 2,900A to 30,000A, the latter, 1 cm to 45 meters. This is illustrated graphically in fig. 13.

In addition to the radiation energy, the sun emits particles, consisting of electrons, protons and stripped nuclei of atoms. None of these particles reaches sea level but their effects will be discussed later.

The radiation suffers depletion due to scattering and absorption by

1. Ozone
2. Water Vapors & CO_2, and other gases
3. Ionized regions
4. Clouds
5. Dust and Smoke.

The attenuation of the radiation will depend upon the path length through the atmosphere. The rate of attenuation is a function of the wavelength, shorter wavelengths being more rapidly absorbed or scattered. As molecular scattering is inversely proportional to the 4th power of the wavelength, the shorter wavelengths never reach the earth's surface in sufficient quantities to present a serious biological hazard.

The total energy reaching the earth's surface on a typical desert day is 105 watts/sq. ft. (1.6 calories/minute/sq. cm) and has an approximate composition of

51% infra red
44.5% visible light
4.5% ultra violet

The seasonal and latitudinal variations of the total energy received at the surface of the earth are shown in Table 5.

As we have shown earlier, this radiation is the factor which determines temperatures, humidity, ionized layers and other conditions.

Latitude	21 Mar.	21 June	23 Sept.	21 Dec.
80 deg N	155	1060	153	0
60 deg N	447	979	442	50
40 deg N	486	991	677	318
20 deg N	841	935	832	605
0	896	790	885	843
20 deg S	841	567	832	999
40 deg S	686	297	677	1060
60 deg S	447	47	442	1046
80 deg S	155	0	153	1136

Table 5. Variations of solar energy at earth's surface. Values quoted in calories per square centimeter per day.

Noise

Man-made causes of noise are beyond listing. Natural sources are largely from space, the sun and local weather conditions.

Lightning produces, in addition to a heavy local disturbance, long-distance phenomena known as "whistlers" in the low frequency bands.

The sun produces erratic disturbances particularly during sun spot cycles. Radio emission is also detectable from the moon and the planet Jupiter.

There are seven other identified noise sources in space, some as far as 270 million light years away.

Cold hydrogen atoms in space (about one per c.c.) give

Nuclear particles

In addition to the energy radiated by the sun, the earth's atmosphere is being constantly bombarded by charged particles, consisting in the main of stripped nuclei of atoms. These particles, called primary cosmic rays, have estimated energies in the range 10^9 to 10^{17} eV, (about ½ foot lb.) which is far in excess of the fastest particles produced in any laboratory. These particles enter the atmosphere but never penetrate to within 24 Km of the earth's surface as they collide with molecules of the atmosphere and produce secondary particles, such as mesons, neutrons, photons, electrons and positrons, some of which arrive at the earth's surface.

Cosmic rays coming in at the equator are deflected by the position of the earth's magnetic field and the concentration reaching the earth is about 2.5 particles per minute per square centimeter. At the poles the earth's magnetic field is vertical, the cosmic rays are not deflected, and about 22 particles per minute per square centimeter reach the earth. No appreciable deflection exists at latitudes higher than 50 or 60 degrees.

As an indication of the magnitude of this environment, the primaries are known to be capable of penetrating up to 15 cms of lead and the secondary particles, which comprise the greatest biological hazard, travel in all directions and can be encountered at all altitudes.

Of lesser energy and importance from an environmental standpoint are the nuclear particles which are being constantly emitted from the earth itself. These contribute to the "space charge" which forms the electrostatic field previously mentioned.

Conclusion

All environments vary with time, some slowly and imperceptibly, others with a speed that is difficult to record. The rhythm of variation is for the most part dependent on changes in location with respect to the sun and the two principal cycles are therefore daily and yearly.

Because conditions change with altitude, the accurate definition of an environment requires three dimensions in space and one in time. Some conditions can be represented for design or simulation purposes by mean or representative values and a time factor. Others are practically indefinable by this means and perhaps may require a statistical summation or broad band approach.

While high altitude work by rocket and missile investigations has opened up new areas of simulation, there still remains much that is unknown about our surface conditions of temperature, humidity and the like. Our methods of classifying surface conditions are still far from comprehensive.

Fortunately the work undertaken by all the nations participating in the International Geophysical Year will probably resolve many problems and add much to what is known. The time lag in applying this knowledge will probably be considerable, as a vast amount of information must be digested, assessed and reported. Still more time will be involved before the data influence our testing methods or standards.

END

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2. *Advances in the physics of the upper atmosphere since 1950, by E. O. Hulbert, Naval Research Lab., Oct. 1955.*
3. *Upper atmosphere research report No. IV, by Newell and Sirey, NRL, USN, Oct. 1947.*
4. *An investigation of atmospheric properties at great altitudes, by H. K. Kallman, Rand Corp., Feb. 1953.*
5. *Investigation in the physics of atmospheric ozone, by V. H. Regener, University of New Mexico, March 1950.*

A complete list of 42 references prepared by the authors may be obtained by writing to: The Editor, Canadian Electronics Engineering,. Box 100, Toronto, Ont.

Does pre-ageing of tubes pay off?

STANLEY E. A. PINNELL, MSC

In connection with equipment for use on the Mid-Canada early warning radar line, pre-ageing tests were carried out on 17 different tube types. The results are presented and discussed, and the concept of comparing "cost per reject" with the cost of a failure during the same period in service is introduced. Further details are available.

During the first eight months of 1956 a program of pre-ageing of certain types of tubes for use in the Mid-Canada Line was undertaken by Pylon Electronic Development company, ltd., Montreal.

The purpose of this pre-ageing was to locate and reject "rogue" tubes that are subject to early failure in service. Information and records arising out of this program was obtained by Pylon on their own initiative and expense.

The exact conditions of ageing differed for each type of tube. Details of the circuits used and the electrical limits applied can be obtained from CEE. Broadly speaking, most tubes were aged with normal heater voltage and approximately half dissipation. Diodes were aged at half maximum rated current. The tubes were all aged for fifty hours, with readings taken initially, at 25 hours, and at 50 hours. G_m measurements were made only at the end of 50 hours.

The electrical limits which were assigned were quite wide, so that only a small percentage of tubes were unacceptable. To that extent, the experience obtained could be expected from well-designed circuitry, in which wide variations in characteristics are permissible. The figures are not at all representative of the performance to be expected from critical circuits.

Causes of rejection

Many causes of rejection were found apart from exceeding electrical limits. While it is not completely possible to classify the various rejects according to the nature of their defect, some general information can be given. For example, open heaters were extremely rare, except in the case of 6080's, where 16 or 17 were found in one batch. With the Type 6252, because of its construction with a single cathode, there is the possibility of unbalance between the two halves of the tube; this was responsible for most of the rejects. However, a considerable number exhibited initial grid-cathode shorts. All but two of the failures of the Type 5651 were due to cracking of the envelope in operation. About half of the failures of the Type 5876 were due to breakage. However, the over-all failure rate was not excessive. These tubes showed a marked decrease in plate current during the first 25 hours (approximately 15%), remaining stable for the second period. Since this tube is used in critical rf circuits, the pre-ageing helps to ensure stable operation.

The numbers of each type aged and the numbers and percentages of rejects are given in Table 1. In some cases only a small number of a particular type were aged, and it is indicated that these results are not significant. It should be borne in mind, however, that the other results are significant only to the extent that tube characteristics are similar from manufacturer to manufacturer and from batch to batch. In nearly all cases the tubes were received in a number of shipments and in some cases, for example, the 6AU6's, they were of several brands. Certainly there is a very significant difference between the percentage of rejects for the 5763 and for the 6AU6WA's. In addition, the 5763 showed remarkably identical characteristics from tube to tube, as well as stability with time.

Considerable interest has been shown by the Services in the pre-ageing of tubes and there are many viewpoints on the value of this step. It is known as a general rule that it is worthwhile in special cases, for example, encephalographs; and quite uneconomic in others, for example, home radios. As an aid to establishing a criterion for determining whether or not to undertake pre-ageing, "cost per reject" is tabulated in the fourth column. This is the cost of locating a "rogue" tube of each of the particular types. In many ageing programmes the figure to be expected would be somewhat lower, as narrower limits would mean more rejects. The figure quoted includes the costs of packing and unpacking and building special racks and test panels.

Economics important

In cases where a user is able to estimate the cost to him of a tube failure, he can decide on economic grounds alone whether it pays to pre-age, by comparing the estimated cost of pre-ageing with the estimated cost of a tube failure. It is apparent from the experience obtained in this series of tests that the cost of locating a "rogue" 6252, for example, by pre-ageing is quite low. It would therefore seem to be a worthwhile procedure in many commercial as well as military applications. On the other hand, the cost of locating a "rogue" 5763 is extremely high and there are probably few applications where this expenditure would be justified. END

Readers requiring further information on these tests should write to: The Editor, Canadian Electronics Engineering, P.O. Box 500, Toronto.

JAN Type	No. aged	No. rejected	% rejected in 50 hrs.	Cost per reject, $
2B22	802	7	0.87	143.00
3B28	4561	21	0.46	228.00
6AK5	25	Nil	* —	—
6AL5W	40	Nil	* —	—
6AU6WA	3986	43	1.07	102.00
6AV6	775	5	0.65	215.00
6BF6	875	17	1.95	71.00
6C4	10	Nil	* —	—
6X4	15	Nil	* —	—
OB2WA	584	2	0.34	365.00
12AT7WA	1749	30	1.72	70.00
12AX7	30	2	*6.7	18.00
5651	309	12	3.88	48.50
5763	2574	4	0.15	935.00
5876	1334	11	0.82	141.00
6080	8054	66	0.82	186.00
6252	882	57	6.46	32.50

*Not significant

Table 1

Auto-call operates unattended teletype stations 101

An automatic selector system which provides for the maximum possible utilization of a teletype circuit and allows for unattended operation of stations on a party-line teletype system has been developed for commercial use by Canadian National Telegraphs engineers.

The system, now in operation in several large private wire teletype networks, provides for automatic sending of a call-line sequence to all stations on a party-line circuit.

Using the Auto-Call method of operation there is no need for a teletype operator to man the equipment continuously throughout the day.

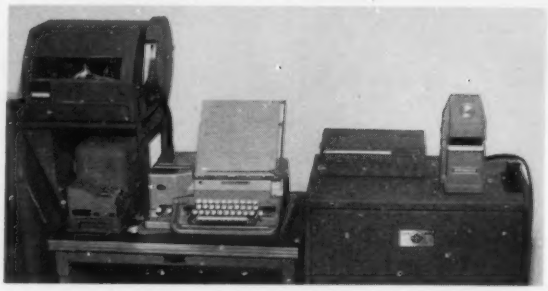
When the operator is given traffic to transmit, the message is prepared in perforated tape form and placed under the transmitter latch. Upon receipt of the station call-in signal, it will be picked up and transmitted to the required station or stations automatically.

The Auto-Call control system works in conjunction with a Model 28 teleprinter and its associated selector mechanism.

When the Auto-Call unit sends out its coded signal to a station on the circuit, the received signal activates the called machine, turns on its transmitter, which then proceeds to send the perforated combinations in the message tape to the desired on-line printer connection.

A coded end-of-transmission signal contained in the message tape will be recognized by the Auto-Call control unit and restart the call cycle.

The next call is then sent to line to invite the next station in the call sequence to send. If an end-of-message code is not included in the message tape, the recycling will be effected by a time-delay unit which will activate the Auto-Call control after an idle line period of three to twenty seconds.



This time interval is usually determined by the customer's requirements.

A station may transmit to any other station in the system, or to all of them simultaneously if so required.

The operator at the control point, usually the head office, has the ability to pre-empt the circuit for transmission of important messages.

However, the circuit is arranged so that a station does not lose its turn to send as a result of a pre-empt call by the control office.

A special feature of the unit is its "plug-in" internal construction. Each of the important component parts of the machine is built as a unit in itself. This enables replacements and repairs to be made quickly and easily.

In addition, the control panel of the Auto-Call unit is separate from the mechanism itself, and is small enough to be placed on a desk.

The Auto-Call unit was designed by Canadian National-Canadian Pacific Telegraphs engineers, and built in CNT shops in Toronto.

Target simulator trains radar operators 102

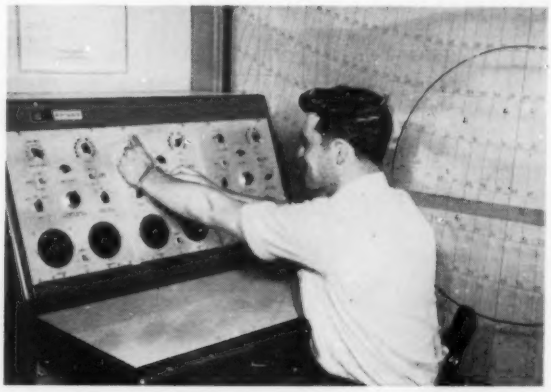
Philco Corporation's Government and Industrial Division has developed a radar target simulator for training radar operators. They will be used by Federal Electric Corporation at its training headquarters in Streator, Illinois, and on the Distant Early Warning (DEW) line.

Since the simulator does not interfere with normal operation of the radar equipment, both real and synthetic radar signals may be displayed simultaneously.

When operated in conjunction with an early warning radar system, the simulator generates azimuth, range and video information for separate targets which will manoeuvre realistically under the precise control of the operator. It achieves a high degree of realism and accuracy through X-Y integration programming and an accelerated time-scale azimuth gating circuit.

Using electronic integrators with high loop gains, the X-Y programming provides uniform, accurate and continuous simulation of aircraft courses through the vicinity of the radar origin as well as at long range.

The accelerated time-scale gating circuit has the advantage of generating a realistic constant range arc in simulation of an echo blip, while still responding to the



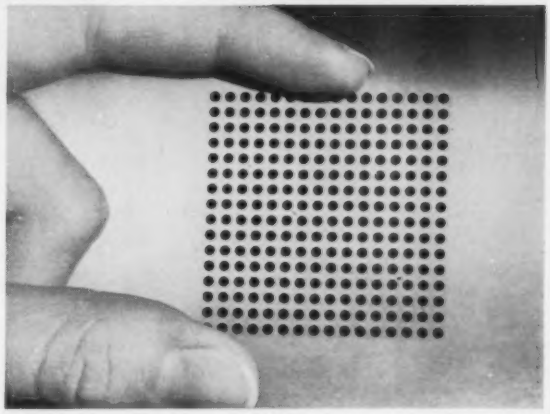
antenna sweep at the exact radar pulse repetition frequency. The simulator requires only three connections to the radar (trigger input, synchro input and video output).

Magnetic-film computer memory is successful 103

A high-speed magnetic film memory is now in operation as a part of the TX-2 digital computer at the Massachusetts Institute of Technology's Lincoln Laboratory. It has a capacity of 32 ten-bit words, suitable for evaluation testing, and serves as an experimental prototype for larger units. This new memory, and the TX-2 computer of which it is a part, were developed by Lincoln Laboratory under United States Air Force contract, with the joint support of the Army, Navy, and Air Force.

The read-and-write cycle time of 0.8 microseconds is consistent with the speed of the computer itself, although bench tests demonstrated successful operation at a cycle time as short as 0.4 microseconds. Net driving current for writing is 150 milliamperes, and one-millivolt output signals are obtained from individual memory elements.

Each memory element is a circular spot of Permalloy film (82 percent nickel, 18 percent iron) 750 Angstroms thick, 1.6 millimeters in diameter, centered 2.5 millimeters apart. The spots are deposited by evaporation on a flat glass substrate, 0.1 millimeter thick, in 16 x 16 unit arrays. One of the experimental arrays is shown in the photograph.



A thin film memory has several potential advantages over the familiar ferrite toroidal core memory: faster cycle time, lower power dissipation, greater compactness, and simpler fabrication. The unit now in operation confirms these expectations, although none of these factors has been fully exploited in this first developmental model.

Now you can screen print your circuits 104

A new method for producing printed wiring directly on ceramic bases without the use of adhesives has recently been developed by A. W. Treptow and Miss Lucille Finneran of Bell Telephone Laboratories. The basis of the new process, which uses standard silk screening techniques for forming the pattern, is a specially formulated copper-bearing paste. Following the printing of the desired pattern on the ceramic base, the piece is fired in a two-step process, resulting in a clean, durable pattern with excellent electrical characteristics.

With the new process, a paste is prepared from a finely ground mixture of copper oxide and a special glass frit, blended with a standard silk screen printing vehicle. The paste is used to print the pattern on the ceramic, and the "card" is heat-dried to remove solvents. After drying, the card with its pattern is fired in air at 750° C for twenty minutes to burn off the printing vehicle. This operation leaves a non-conducting copper oxide pattern, ready to be reduced to metallic copper.

The second firing operation is conducted at 850° C for thirty minutes, in a controlled atmosphere containing hydrogen, nitrogen, and oxygen. The hydrogen in the atmosphere reduces the copper oxides to matallic copper, while the oxygen prevents reduction of other oxides in the system and promotes good wetting of the glass frit and the ceramic. Without oxygen present, a poor bond results.

Printed wiring cards prepared this way can be dip-soldered without bond failure, and without the use of corrosive fluxes. In tests of bond strengths, 20-gauge headed wires were attached to the pattern with an area contact about .01 square inch. Bond failure did not occur until about 2000 psi tensile pull, and even then generally involved breaking out the ceramic rather than bond failure.

With the oxygen in the controlled atmosphere, only 5% glass frit is required in the paste to achieve good bonds.

This small amount of inert material does not greatly affect the conductivity of the copper film. Resistivity of the film is in the order of 0.0015 ohms per square, which is well within requirements for typical printed wiring applications.

The composition of the controlled atmosphere may be forming gas (85% nitrogen and 15% hydrogen) with the addition of 0.4 to 4.5% oxygen. Such a gas mixture is non-inflammable.

The process is suitable for automatic production techniques, and should prove competitive with other printed wiring methods in cost.

There are other potential uses for the new copper paste in addition to printed circuits. With suitable modification of the vehicle, the copper can be applied with a brush or spray gun. When fired, these coatings form a good base for making metal to ceramic bonds, using lead-tin solders.

Business telephone can handle 30 circuits 105

A flexible business telephone is being introduced by The Bell Telephone Company of Canada this month. The Call Director has been designed for executives and secretaries in business requiring more than six lines.

Up to 30 push-buttons on one telephone can be used to provide inter-office communication, call holding, signaling, and conference arrangements between extensions. The Call Director can also pick up calls on other lines, add other extensions to incoming calls, and automatically connect calls to busy lines as soon as the called phone is free.

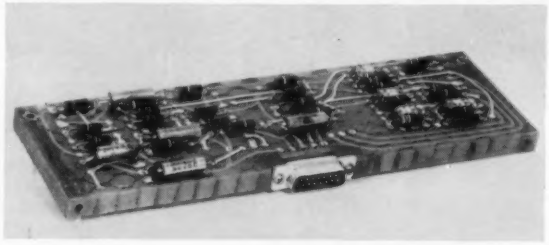
Plug-in type connectors permit fast installation and rearrangement, and extra buttons can be added with minimum inconvenience to the telephone user. Two models are now available—an 18-button and a 30-button set.

Honeycomb panels make novel circuit boards 106

Motorola Incorporated's Military Electronics Division is making plastic electronic circuit panels using a reinforced fibre-glass honeycomb core — a high strength, light weight material manufactured by Hexcel Products Inc.

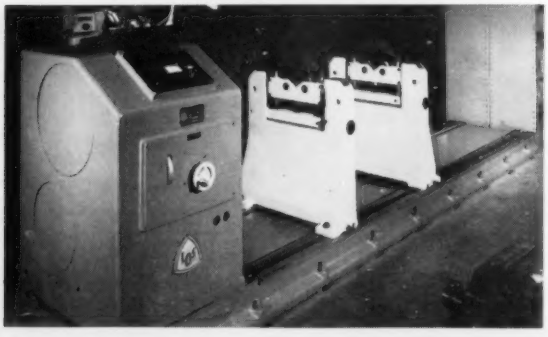
The honeycomb core, which consists of a series of reinforced fibre-glass cells bonded together, is used as a support for electronic circuitry used in airborne missiles. Moreover, the core permits engineers to use ultra-thin printed facings on the panel (0.015″), thus simplifying the problem of solder connecting circuitry through the facing. The core's open cellular construction also makes possible location of circuitry and components on the inside of the panel.

The bonded assembly has undergone tests with 5 G loading repetitively applied at frequencies from 0 to 700 cps. It was also given rigidity tests using four point corner suspension at temperatures from —48 F to +160 F under conditions of extreme vibration.



Dynamic balancer improves machine life 107

The increasing complexity of modern refineries places a premium on the dependable operation of auxiliary equipment. As electric motors, pumps and other rotating machinery progress through the Imperial Oil Co. maintenance shop, therefore, they are quickly and accurately checked for dynamic balance on a Losenhausenwerk Model UA-1000 Balancing Machine, supplied by A. C. Wickman Limited.



As the photograph shows, the component to be balanced is supported on the bearing carriers, in the same position as it occupies in use. It is driven by the Balancing Machine and the amount of unbalance is measured in the two non-oscillating bearings, by means of piezoelectric elements. The voltage generated by these elements is amplified and fed into a computer-like network. By adjustment of two or more potentiometers, the actual weight of unbalance in two or more planes of correction is displayed on the meter of the machine. The angle of unbalance is given on a graduated dial on the front of the machine.

For your library

How to make decisions under conditions of uncertainty

Elementary Decision Theory

Herman Chernoff and Lincoln E. Moses; John Wiley & Sons, Inc., New York; 364 pp; $7.50

Reviewed by H. C. Ratz, Senior Research Associate, College of Engineering, University of Saskatchewan.

The objective of this book is to introduce statistics by way of decision theory. While high school mathematics are a sufficient prerequisite, the reader soon becomes acquainted with notations used in function, games and set theory. Statistics is presented as the problem of decision making under conditions of uncertainty rather than the processing of data. Thus, from the decision theory point of view, statistics becomes the description of games against nature.

The reader is introduced to the fundamental problem of selecting strategies from the available cources of action depending on his relative losses from the consequences and his observations on the state of nature. The methods of representing data by the use of the mean, variance, probability density and cumulative distribution functions are simply presented. Insight is given to the important and fundamental ideas of utility and Bayes strategies, including the arithmetic computation of the latter. Having thus introduced the basic statistical ideas underlying decision theory, the classical problems of estimation, confidence intervals, and significance and hypothesis testing are treated as part of the framework of the theory. This application to familiar problems emphasizes the authors' formulation of statistics as the making of decisions.

This book provides an elementary introduction to many basic principles in statistics and game theory which are united in the decision making process. In the presentation of the material, fundamental principles are often suggested by examples rather than separately explained, and in many cases the usefulness and clarity could be improved considerably by the use of elementary calculus. This is a primer intended to acquaint the non-mathematical student with the vocabulary of decision theory. A partial list of answers to exercises is included, and each chapter concludes with a useful summary.

Theoretical Electromagnetism

W. R. Myers, MSc; Butterworth & Co. (Canada) Ltd., Toronto; 274 pp; $8.50

The aim of this work is to provide a concise introduction to the essentials of electromagnetic theory, together with a few examples of its application. The book is designed for undergraduates reading for an honours degree in physics. The author, who is a lecturer in physics at Southampton University, England, assumes the reader to be familiar with electricity and magnetism up to a level somewhat higher than Senior Matriculation.

Mathematically the treatment has been kept simple, but the use of vector methods is essential. The four-dimensional Giorgi system of units has been adopted and to assist those who are accustomed to a three-dimensional system, a table of units and conversion factors for electrical quantities is included.

A selection of worked examples in electrostatics is given at the end of the book. Most other problems in electromagnetism are solved by simple extensions of the mathematical procedures outlined in these electrostatic examples and therefore only a few examples are discussed in the main text.

In trying to keep the book within a small compass, many important topics are not discussed. The most serious omission is probably that of relativity; electromagnetic theory provides a natural approach to relativistic mechanics. Other omissions include radiation and the theory of inhomogeneous media. However, the author gives a short bibliography of more advanced texts for further reading.

Tube Manual

The 1960 edition of "Essential Characteristics" contains 260 pages of information on receiving, picture and special purpose tubes. It may be obtained at $1.25 from Canadian General Electric Co. Ltd., 189 Dufferin Street, Toronto, Ontario.

Thermistor Data & Curve Computer

This Fenwal Electronics slide rule aids in thermistor design work. After selecting the thermistor shape desired, and its resistance at 25 deg. C., the user can read resistance directly opposite all temperature points on the curve of the appropriate thermistor. The five in. by eight in. slide rule contains information on dimensions, dissipation and time constants, and maximum temperature limits. U. S. price is $1.00.

Rousseau Controls Ltd., 640 Decourcelle St., Montreal.

Ultrasoundings

A new quarterly illustrated review of ultrasonic progress issued by and available free from Acoustica Associates, Inc., Dept. P, 26 Windsor Ave., Mineola, L.I., N.Y.

Science films and records

Six new audio-visual aids to science education have just been produced by Bell Telephone Laboratories. They are available on loan without charge to professional groups as well as to educational institutions through local Bell Telephone Company offices.

Crystals—an introduction: 16mm color movie with sound; 25 minutes running time. This classroom film is primarily designed to provide an introduction to crystallography for students of electrical engineering.

Brattain on semiconductor physics: 16mm b&w film with sound; 30 minutes running time. Walter H. Brattain, Nobel Laureate in physics, gives an introductory college-level lecture on the physics of semiconductors.

Submarine cable system development: 16mm color film with sound; 18 minutes running time. An informational film describing the work of mechanical engineers in designing and developing underwater communication systems.

Zone melting: color filmstrip; 133 frames; narration on two 33-1/3 records; 45 minutes. Describes the new method of ultra-purifying solids and controlling the distribution of impurities in solids.

The formation of ferromagnetic domains: color filmstrip; 132 frames; narration on two 33-1/3 records; 45 minutes. Discusses the physical principles of domain formation with particular emphasis on the energies involved in the process.

The science of sound: two 33-1/3 microgroove recordings; 90 minutes. Demonstrates 19 different acoustic phenomena with narration written by Bell Laboratories scientists.

Catalogues and brochures

Mycalex News. This new house organ will be published periodically with the objective of containing news of the company's activities and developments in the field of high-temperature insulation which will be of interest to engineers in the electrical, electronics and allied industries. Mycalex Corp. of America, Clifton, N.J. (141)

Nameplate designing for engineers. 20-page booklet provides information for engineers and draftsmen designing nameplates for prototype or quantity production. H. G. Dietz Products Co., Long Island City, N.Y. (142)

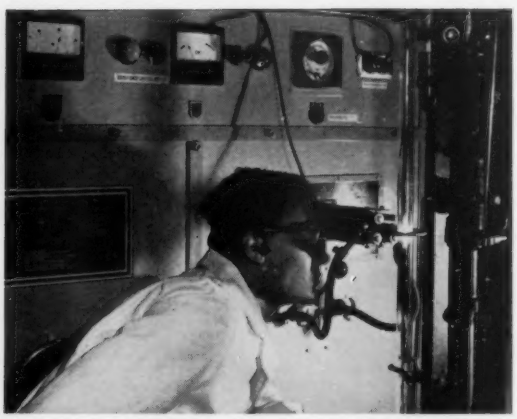
Microwave waveguide chart. Adjustable waveguide chart indicates RETMA and JAN standards for rectangular waveguides and flanges. One side shows RETMA specifications for range 960 mc to 110 kmc. The other side shows JAN specifications for 1.12 to 90 kmc. Polytechnic Research & Development Co. Inc., Brooklyn, N.Y. (143)

How to use protective coatings efficiently. 14-page bulletin 79 provides suggestions for proper use of Humiseal insulating and protective coatings in electronic applications. Columbia Technical Corp., Woodside, N.Y. (144)

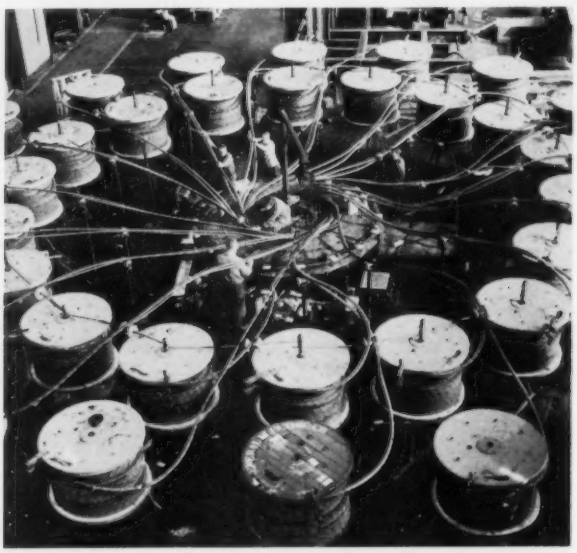
Transformers and electronic cabinetry. Catalogue 70 provides detailed information on all additions to stock lines of transformers, cabinets and hardware. Hammond Manufacturing Co. Ltd., Guelph, Ont. (145)

Giant British computer can do over 30,000 calculations per second

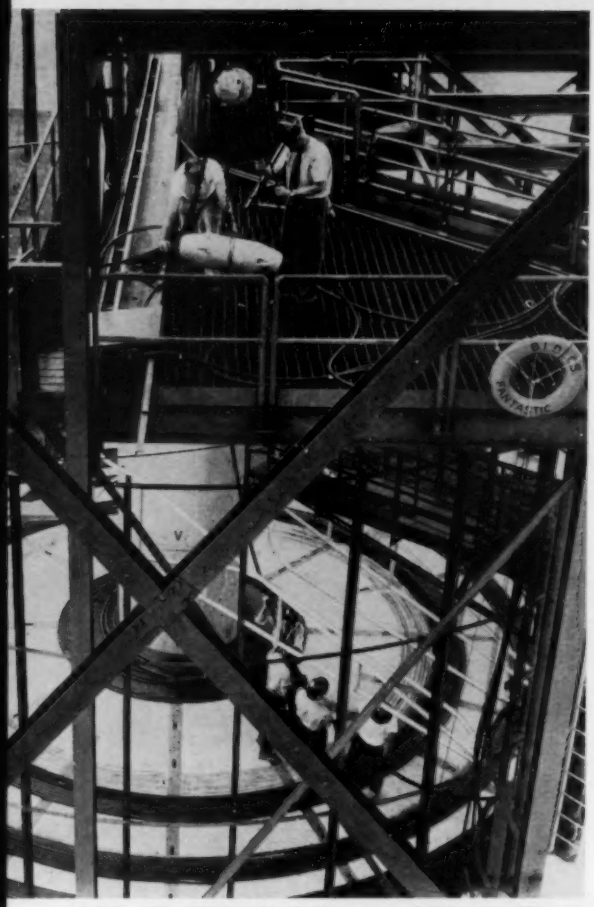
ACE, built at the National Physical Lab. near London is a serial computer using 48 binary digits at rate of 1,500,000 digits per sec. Main working store consists of 24 mercury delay lines of 32 words each. Rapid access storage is with delay lines of 1, 2 and 4 words capacity. Backing store is four magnetic drums containing total of 32,768 words.



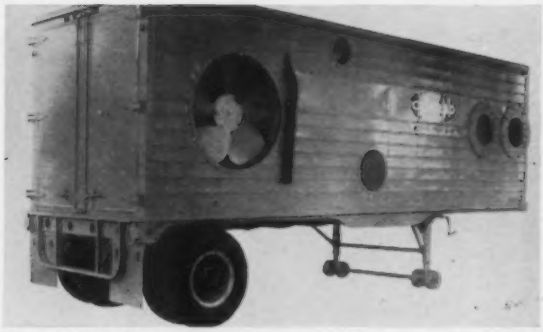
Philips rf induction generator is helping University of Toronto metallurgists zone refine very pure iron. Repeated refining can produce 99.999 percent purity.



Huge induction coil being made by General Electric Co. will store energy for USAF hypersonic wind tunnel at Arnold Engrg. Development Centre. It will carry 1,000,000 amps.



Cable ship Fantastic, built on a hill near Chester, N.J., helps Bell Telephone engineers study methods of storing and laying underwater communication cables.



Conrad Mobile-Temp can supply conditioned air, heated to 300 F or cooled to —100 F. Blower circulates air through ducts to enclosure around missile or other item on test.

The transistor hasn't and won't knock out the tube says Sonotone Corp. They should know, having experience in both. In picture, worker assembles Sonotone tube cage.

Light consisting of $3x10^{-6}$ millilamberts on the scene are sufficient for General Electric Company's new image orthicon. The right half of this picture was taken with normal lighting. On the left, with the lights out, the camera still transmits a picture utilizing only the glow from a cigarette lighter.

Head table guests enjoying a lighter moment at the IRE banquet are (l to r) R. A. Hackbush, director of engineering, Electronic Industries Association of Canada; Mrs. Hackbusch; D. A. Golden, Deputy Minister, Dept. of Defence Production (guest speaker); E. L. Palin, convention chairman; Mrs. Palin; E. Weber, president of IRE; Mrs. Weber.

Quality, maturity, quiet optimism mark 1959 IRE Canadian Convention

The 1959 IRE Canadian Convention and Exposition opened very quietly. Exhibitors were in early to polish up their displays, but visitors were still in the minority in the middle of the afternoon

By closing day exhibitor enthusiasm was astonishing. Of all those approached by CEE editors on Friday, not one failed to claim that he had made a large number of actual or potential sales contacts

Exhibitors claimed that, although there were fewer visitors, they were of a higher calibre and genuinely interested in displays. Visitors were impressed by competence of personnel manning booths

Total attendance was down this year, partly due to elimination of evening show hours and public day. Technical attendance was 7,720 compared with 9,122 last year, 7,647 in 1957, 7,818 in 1956

"... the IRE Canadian Convention can perform yeoman service both in strengthening domestic professional development and promoting international trade"—D. B. Sinclair, vice-president, IRE

"... the entire conception of production sharing rests on the assumption that, on a selective basis, Canadian technology and production can make the most of the new opportunities"—D. A. Golden

Some technical sessions drew larger audiences than ever before. Some had standing room only. Papers were of very good quality and the entire program was well balanced in its subject range

This year the ladies had a well-organized program with a tour of Toronto, visit to Niagara Falls and look at model of St. Lawrence Seaway. Ladies' program should be a permanent feature of meet

When the doors of the Automotive Building swung open on October 7 a great trickle of visitors moved slowly in towards the registration desk. The pessimists, and that includes most exhibitors on opening day, began their annual dirge, accompanied by the slow clacking of a few heels-on-pavement resounding through the vast empty spaces.

By Friday afternoon there was a different atmosphere altogether. Several of the exhibitors claimed to have more than covered the cost of their show participation in sales made on the spot, or in solid leads. There may have been a few disappointed exhibitors, but the editors of CEE did not find any of them during discussion on the closing day.

Attendance was down quite a bit this year. Part of the reason was because the exposition closed during the evenings, and there was no public day, as in previous years.

The final figure was 7,721 as opposed to a total of 10,142 last year (9,122 technical and 1,020 public visitors). A true comparison, then, would place attendance down 1,600 from last year.

However, the delegates who did attend had a genuine interest and purpose. Several exhibitors commented on this fact, claiming that almost every visitor calling at their booths provided a genuine sales lead.

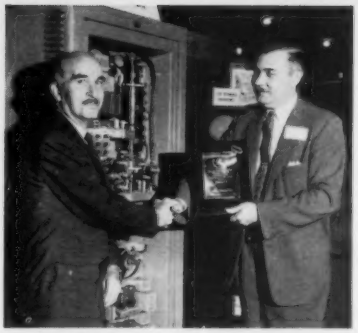
On their part, the visitors found that personnel manning the booths were of a much higher technical calibre than in former years. This meant that answers to technical problems could be provided on the spot.

The 1959 convention was officially opened by Dr. Donald B. Sinclair, vice-president of IRE. Most of his address is given on page 21 of this issue.

Exhibit awards

Two exhibit awards were made this year, one for the best Canadian-developed product and the other for a component. The product award went to Dr. T. W. R. East, Sen. Mem. I.R.E., Section Head, Circuit Design at Raytheon Canada Ltd., Waterloo, Ont. for the Model GP803 Scan Converter. The component award was won by H. A. Leah, Instrument Engineer with Bach-Simpson Ltd., London, Ont. for a Frequency Controller-Indicator. It is of interest to note that Bach-Simpson also won last year's single exhibit award.

H. A. Leah, Bach-Simpson, shows his Component Award plaque to H. Ross Smyth, chairman, Awards Committee.



J. R. Cann (r), executive v-p and general manager of Raytheon Canada Ltd., congratulates Henry E. Rice, Jr., member of the team that won the Exhibit Award for a product.

The Exhibit Award Committee, under the chairmanship of H. Ross Smyth, National Research Council, judged the entries under the following headings: Canadian contribution; originality , patentability; practicability or usefulness; quality of design; human engineering; marketability; presentation of material to the committee; effectiveness of display. They stressed that only items that had been formally entered for the awards were considered—it was not enough to simply have an item on display in a booth.

Technical sessions

Once again the papers delivered at the technical sessions proved to be of a very high calibre. This is as it should be since the primary objective of the annual meeting is dissemination of technical information among electronics engineers in Canada.

With four years now on the record some interesting trends and statistics are available. There is definite evidence to show that the most successful sessions are those that have been planned as a unit right from the beginning. The "Topsy" sessions (them as just grew like) invariably drew fewer people, despite the fact that they included some top notch papers and speakers.

Members of the technical papers committee have been indulging in a little statistical analysis and came up with an interesting curve. Using the total registration of technical visitors as the base (7,720 in 1959), 20% attended the sessions this year.

Figures for all years to date are:

Year	Registration	Sessions
1956	7,818	35%
1957	7,647	28%
1958	9,122	21%
1959	7,720	20%

This indicates that, after an initial surge caused by such things as novelty and curiosity, the technical sessions appear to be settling down to a healthy standard of attendance.

And there was good reason to attend sessions this year. Solid state electronics, a subject important to almost every field of electronics today, drew the largest attendance. In fact, there was standing room only.

Space electronics, communications, stereo broadcasting, education and engineering management were all well attended. All were planned sessions and dealt with subjects having particular interest to Canadians, or with subjects on the leading edge of this advancing technology.

Ladies' program

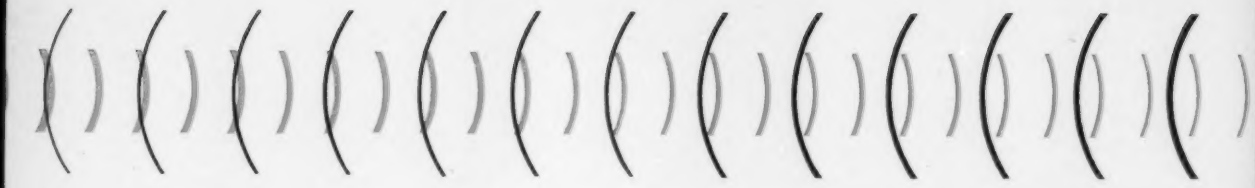
For the first time in the history of the IRE Canadian Convention, a full program of planned activities was arranged for the ladies who attended.

Ladies' social activities were arranged by: (seated) Mrs. Norris and Mrs. Barclay; (standing) Mrs. Armitage, Mrs. Palin and Mrs. Pounsett.

These included coffee and get-acquainted hours at the Royal York Hotel each morning, a sightseeing bus tour of Toronto, a full day scenic historical tour to Niagara Falls with lunch in the Rainbow Dining Room of the Sheraton-Brock Hotel overlooking the falls, and a trip to view Ontario Hydro's model of the St. Lawrence Seaway.

The ladies also graced both All Industry Cocktail Party and the Banquet by their presence in good numbers. These were happily increased by the presence in Toronto of the wives of several of the directors of The Institute of Radio Engineers, including Mrs. Ernst Weber, the IRE president's wife.

(Continued on page 42)



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tested antennae for CONTINENTAL DEFENCE

The Winnipeg Division of Bristol Aero-Industries Limited has established, just southwest of the city, the first radar and communications antennae test range in Western Canada. This unique facility adds an important new dimension to national defence.

It means that Bristol can now measure the electronic capability of the antennae built by the company for both military and commercial application and can deliver completely proven assemblies to the customer.

Bristol is the exclusive manufacturing and sales agent in Canada for D. S. Kennedy & Co., Cohasset, Mass., and has access to the specialized knowledge and capabilities of this company—one of the world's foremost designers and manufacturers of radar and communications antennae.

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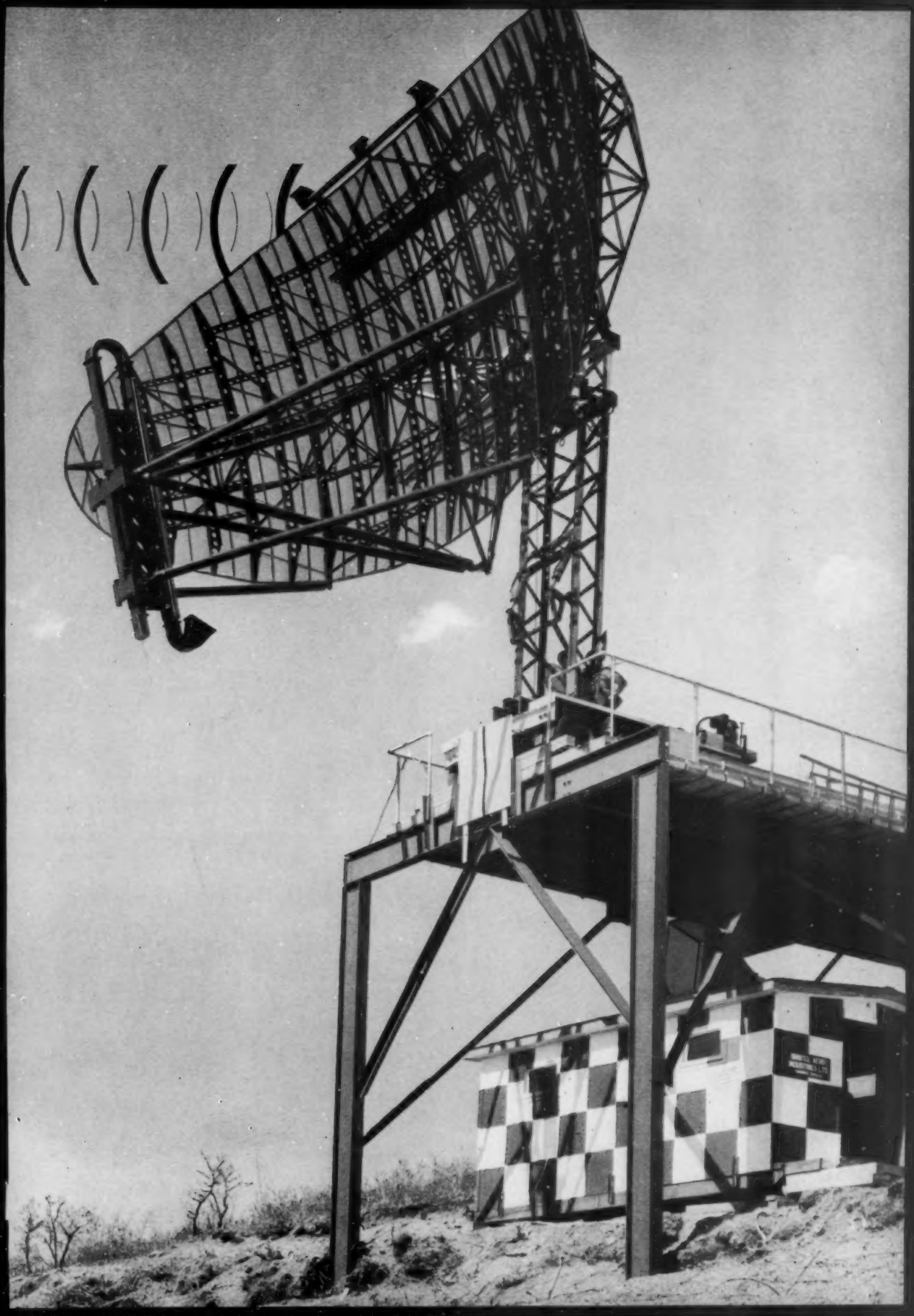
5

Fifth in a series on the aircraft and engine overhaul, servicing and manufacturing facilities of Bristol Aero-Industries Ltd.

For further information mark No. 16 on Readers' Service Card



Papers and diplays set high standard at IRE Convention

Pinch-hitting for her husband, Mrs. R. Scott gave an excellent presentation of his paper at the session on engineering management.

At the E.M.I.-Cossor booth, F. Martin, left, shows some stroboscope tricks to G. Smedmor, convention manager, and L. V. Kavanagh

Two talented high-school students displayed work at the CEE booth. J. Labow, second from left, and F. Baker won awards at the Science Fair earlier this year

V. Currie of Pye Canada Ltd. got information on locomotive antenna from P. Yachimec and designer F. Buckles of Sinclair Radio Labs Ltd

Exhibitors found that visitors were more intent on getting specific information this year. This scene at Canadian Research Institute booth was quite typical

Interested in manufacturing rights to a new invention? Canadian Patents and Development Ltd. (NRC) had some good ones on display, and some are still available

J. Eimer, left, of Strippit Tool & Machine Co. sold this fabricator to D. V. Carroll, right, of T. M. C. (Canada) Ltd. It is designed for punching out individual chassis

E. D. Smith makes some adjustments on this Airtron "designed-in-Canada" x-band ferrite mixer duplexer.

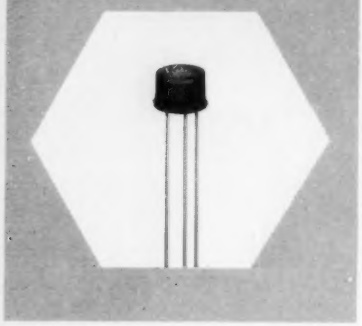
Vic. Ames of C. P. Clare Canada Ltd. had numerous requests for information on this filament voltage regulator.

Many fine instrumens were on display. Here, D. Kirschner shows new FXR Inc. meter to H. Chamberlain.

Several closed circuit television systems were shown this year, indicating increased interest in Canada. Sylvania system can use standard receiver for monitor

Students at Ryerson Institute of Technology designed a special effects generator and synchronized it with a recorder so that the "face" moved its mouth as it "talked"

TI SEMICONDUCTORS
ANYWHERE IN
CANADA
OVERNIGHT



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For further information mark No. 28

IRE convention report

The ladies' events were arranged by a committee under the chairmanship of Mrs. Eileen Barclay, wife of the IRE Canadian Region Director. Plans are already under way for next year's program.

IRE directors meet

This year the IRE International accepted a long-standing invitation from the Canadian Convention committee, and held meetings in Toronto concurrent with the convention.

A brief moment of informal chat with G. W. Bailey, left, executive secretary of IRE, Dr. D. B. Sinclair, vice-president of IRE, and CEE editor Harold Price.

On the first day a Fall Executive Meeting was held, and was followed on the second and third days by a meeting of the Board of Directors. This was the first time that such meetings had been held outside the continental United States. Host was A. P. H. Barclay, Canadian Region Director.

One of the distinguished guests at the banquet was J. H. Foote, (r) president of AIEE, shown with Prof. G. F. Tracy (l), vice-president of AIEE, and R. G. Bullock, chairman of the social activities committee.

Special attention was paid at these meetings to the international aspects of the IRE, which now has members in 83 countries, with eight regional organizations outside the U. S.

George W. Bailey, executive secretary said that there are 27 members behind the "iron curtain," and that

(Continued on page 46)

Completely
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Only a complete Canadian instrumentation facility can offer the kind of service Canadians need. Bach-Simpson Ltd. *is* complete — in research, design, tooling and manufacture.

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Others have, and have been completely satisfied!

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The new MODEL '270'

A custom instrument in the Simpson "260" tradition

- Increased accuracy
- Human engineered scales
- Movement overload protection-and a host of other attractive features for discriminating users.

For those who for years have valued the reliability and versatility of the Simpson "260", the Custom-Engineered Model 270 offers a multitude of new features for applications calling for a higher order of accuracy, with no sacrifice in the qualities which have made the "260" famous the world over.

Ranges and scale layouts have been designed for maximum readability with an anti-parallax mirror and knife edge pointer. Precision components and calibration techniques assure accuracies down to ± 1.25% on most of the D.C. ranges, with similar accuracy improvements on other ranges. In addition, the operating manual specifies accuracies on all ranges for a variety of operating conditions, frequency correction curves and a host of useful information.

To conserve this high order of accuracy, a circuit fuse and meter current-limiting diode guard against accidental overload, over and above that provided for in the choice of rugged and generously rated components.

Truly a Custom-Engineered Instrument to suit the present day trend to greater precision in measurement.

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IRE convention report

IRE hopes this number will rapidly grow. Mr. Bailey's application for membership in The Popov Society (the Soviet equivalent of IRE) is now being processed. The Society has proposed reciprocal membership with the Institute, but IRE insists that its ranks are open to all qualified people.

E. L. Palin, general chairman of the convention executive committee, 1959.

Technology, production and defence

Addressing convention delegates at the banquet, guest speaker D. A. Golden, Deputy Minister of Defence Production, had this to say on the subject of integrated defence production:

" . . . the increasing complexity of modern weapons systems and the growing integration of Canadian and United States measures for continental defence . . . . made it abundantly clear that, in future, it would be extremely difficult for this country to undertake alone the development and production of its major weapons.

" . . . it is inconceivable that Canada should view with indifference any substantial diversion of its defence production from Canadian to foreign factories . . . . it represents a substantial investment of Canadian resources, a source of livelihood for thousands, and a major repository of technical and mangerial skills.

" . . . The development and production of defence equipment has a tendency more and more to set the pace of technological progress for a country . . . To cut off the flow of challenging new defence tasks would give rise to at least a threat of technological stagnation. The Government is seeking an answer to this new problem of defence production through co-operative arrangements with the United States, summed up in the term 'production sharing'."

". . . The defence equipment which seems to offer the greatest promise for future production sharing is characterized by a very high degree of engineering content. Canada's ability to share in such programs, therefor, depends on the maintenance and continued development of its engineering capacity. This can only be accomplished if Canadian industry is able to secure development tasks of an advanced character. Once again, the United States authorities have recognized this need and have agreed that production sharing, in the long run, presupposes development sharing.

"In the last analysis, the entire conception of production sharing rests on the assumption that, on a selective basis, Canadian technology and production resources can make the most of the new opportunities."

Student display

Two of Toronto's talented high school students, J. Labow and F. Baker, exhibited their work at the CEE booth. Both had won awards for their work at the Science Fair held in Toronto earlier this year. Then they entered in the U. S. National Science Fair at Hartford, Conn. At this, Mr. Labow won one of the top awards which earned him a week's cruise on a U. S. science ship.

Mr. Labow's entry was a telemetry system for an earth satellite. He called it Canadia 1 and built up all the circuits himself, using parts obtained from commercial supply houses. The instruments in the satellite were capable of measuring and transmitting temperature, density, micrometeorite bombardment, ultra-violet (Lyman-alpha) and cosmic radiation.

Mr. Baker's entry was a corona wind loud speaker. In this type of speaker a wind is generated by ionizing air at one terminal of a high voltage source, then setting it in motion by attracting it to another terminal. This wind can be modulated to produce sound.

Most of the booths this year showed maturity in their arrangement. CEE editors rated International Systcoms Ltd. booth as one of the best.

Mr. Baker's speaker was in operation during the IRE show and CEE would like to acknowledge the assistance given by Canadian Research Institute. Their loan of a power supply and transformer made the demonstration possible.

Next year

While some of the plans for the 1960 IRE Canadian Convention and Exposition have not even been formed, one step has been taken. F. Heath of Canadian General Electric Co. Ltd. has been elected general chairman of the convention executive committee.

As each year passes it becomes increasingly difficult to find new ideas, but we have no doubt that 1960 will set a good standard. END

Nine students from colleges across Canada were the guests of the IRE Canadian Region at the Convention. Shown here after the banquet are (l to r) Lynn Groves, Hamilton Institute of Technology; Darryle Black, Provincial Institute of Technology, Calgary; Duff Plato, University of Alberta; A. P. H. Barclay, IRE Canadian Region Director; F. J. Heath, general chairman of the 1960 Convention; Jack Landolt, University of Ottawa; Achille Leblanc, Laval University; E. L. Palin, this year's general chairman; Terry Bradley, Eastern Ontario Institute of Technology, Ottawa; Donald McDiarmid, University of British Columbia; Roy Young, Ryerson Institute of Technology, Toronto; James Brooks, University of Toronto.

People—continued

Promotions in sales

Two promotions have been made at International Systcoms Ltd. **J. Young,** resident in Vancouver, has taken up the appointment of western area sales manager, responsible for sales of company products and control of dealer set-up.

Mr. Young obtained his M.Sc. from McGill University in 1928 and served several years as a design and research engineer with Canadian Marconi Co. Recently he held the position of manager, patents and external relations division. In 1954 he was appointed director of Canadian Radio Patents Ltd.

J. DiMichele has been appointed assistant to the marketing manager in Montreal. He will be responsible for product promotion, administration and back-up of area sales managers. Mr. DiMichele has served with RCA Victor Co. Ltd., and Canadian Marconi Co.

New sales manager at Ottawa

Ampex American Corp. has appointed **T. D. Dalzell** sales manager for instrumentation products marketed in Canada. He replaces **B. H. Simpson,** former manager at the Ottawa office.

Mr. Dalzell formerly was a technical and sales representative with R-O-R Associates and with Canadian General Electric Co. Ltd. Prior to that he was with Stanley Co. Ltd. in England.

Mr. Simpson, also a former employee of Canadian General Electric Co. Ltd., has been transferred to the head office of Ampex International in Fribourg, Switzerland.

New director of "Met" branch

The Civil Service Commission has announced the appointment of **P. D. McTaggart-Cowan, M.B.E.,** as director of the meteorological branch of the Department of Transport. He succeeds **Dr. Andrew Thomson, D.Sc., M.A., O.B.E.,** who retired recently on superannuation.

Mr. McTaggart-Cowan was born in Scotland, but has lived in Canada since he was a small boy. He graduated from the University of B.C. with first class honors in mathematics and physics. He proceeded to Oxford University with a Rhodes Scholarship and studied the natural sciences. Earlier this year he received the Robert M. Losey award from the Institute of Aeronautical Sciences "in recognition of outstanding contributions to the science of meteorology as applied to aeronautics."

Dr. Thomson retired in September. A Canadian by birth, his extensive career, prior to joining the Canadian Meteorological Service in 1932, included association with Thomas A. Edison in research work during World War I. He is a graduate of the University of Toronto.

Computer design brings reward

The inventor of the R Theta navigational computer, **Wing Commander J. G. Wright,** RCAF, has been awarded royalties amounting to about $12,000. This is the largest amount ever awarded to a member of the armed forces for an invention.

Engineering dean dies

Former dean of engineering and architecture at the University of Manitoba, **E. P. Featherstonaugh,** died last month after a brief illness. He was 80.

Mr. Featherstonaugh graduated from McGill University and served as Dean at Manitoba from 1921 until his retirement in 1949. He was a former member of the National Research Council, and served as president of the Engineering Institute of Canada in 1945.

Reports—continued

Bristol now manufacturing antennas in Winnipeg

Antennas for Canada's long range surveillance radar installations are now being made by the Winnipeg Division of Bristol Aero-Industries Ltd. The company is the manufacturing and sales agent in Canada for D. S. Kennedy & Co., Cohasset, Mass., specialists in radar and communications antennas.

In addition to manufacturing and mechanical test facilities, a pattern test range has been established near La Riviere, Man., with a 6,000-ft obstacle-free sighting plane across the Pembina River valley.

New principals and representatives

Power Service Products, P.O. Box 184, Islington, Ont. has recently been established. They are exclusive Canadian reps. for Cramer Controls Corp., The Electric Specialty Co., and Regulators, Inc. They await confirmation as reps. for Electrovac of Vienna. The company also acts as jobbers for The American Superior Electric Co., Hammond Mfg. Co. Ltd., and Syntron (Canada) Ltd.

The Ahearn and Soper Co. Ltd., Ottawa have been appointed exclusive Canadian representatives for Microwave Electronic Tube Co., Inc. of Salem, Mass. (microwave tubes and devices; TR, ATR, Pre-TR tubes; magnetrons, klystrons; noise tubes; spark gaps; duplexer assemblies and windows).

Radionics Ltd., Montreal are now sales representatives for CBS Laboratories, a division of Columbia Broadcasting System, Inc.

Constellation Components Co., Toronto and Montreal, were recently appointed as distributors of Muirhead synchros, servomotors and other components, covering Ontario, Quebec and the Maritimes. Muirhead Instruments Ltd., Stratford, Ont. continue to handle a wide range of instruments throughout Canada.

Taylor-Leslie Mining and Engineering Corp. Ltd., Toronto now represent La Nationale, Geneva, Switzerland, manufacturers of ultra-fine metal tubing.

Visirecord of Canada Ltd., with 34 sales offices throughout Canada, has been appointed exclusive distributor for the data processing machines made by the American Data Division of American Electronics, Inc., Brooklyn, N.Y.

Conway Electronic Enterprises, Toronto are now Canadian reps. for Acton Laboratories, Inc., Acton, Mass., and will sell and service the complete ALI line of electronic laboratory test instruments.

Firms change address

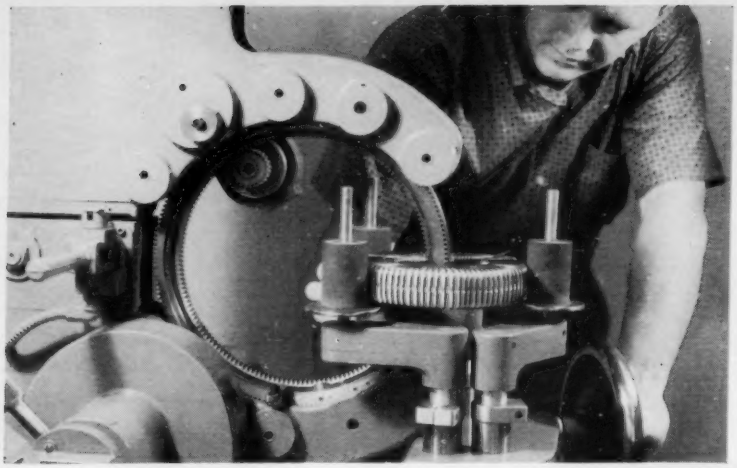
Allied Circuit Techniques Ltd. has moved to 29 Brock St. N., Oakville, Ont. Telephone is VIctor 5-3439.

With the addition of more stocking lines and increased sales and office staff, the E. S. Gould Sales Co. has just moved to larger premises at 19 Le Royer St., Montreal. Both office and warehousing space have been more than doubled.

Companies expand facilities

Erie Resistor of Canada Ltd. plan a 60 by 90 foot extension to their plant at Trenton, Ont. to cope with a constantly increasing workload.

The former Canadian Westinghouse plant at Stratford, Ont. has been bought by Reliance Electric and Engineering Co. of Cleveland, Ohio. A new company, Reliance-Reeves-Master Ltd. will manufacture drives, electronic controls and gearmotors. Negotiations for the company were carried out by N. J. McCartney, vice-president and general manager, Reliance Electric and Engineering (Canada) Ltd., Toronto.



108

109

New products

For further information on New Product items, use the Reader Service cards on pages 57 and 58

Toroidal coil winder 108

Boesch Manufacturing Co. winding machine, Maxitor, has been designed for winding heavy-gauge wire on large toroidal forms. Three interchangeable heads are available. The HW-300 head winds wire gauges from #20 to #7 AWG on forms to a finished outside diameter of as much as 14 in. HW-200 head winds gauges from #24 to #10 to a maximum finished outside diameter of 10 in. The HW-100 head handles gauges from #40 to #22 to a maximum outside diameter of 10 in.

Bayly Engineering Ltd., Ajax, Ont.

Machine installs eyelets 109

The addition of the TH-3 tool holder to the NRLT eyeletting machine which feeds, inserts and flares funnel type eyelets, makes it possible to obtain proper flaring of the eyelets automatically. The TH-3, with a spring-loaded work table, permits flaring only after complete insertion of the eyelet. Another device included on the holder compensates for variations in the thickness of printed circuit boards. The result is prevention of too-early and short flares which can lead to subsequent loosening of the eyelet.

Edward Segal, New York.

Supervisory control system 110

Pulse supervisory, model PS '56 transmits all information in special code groups of 10 pulses each and provides protection against error by detecting any deviation in transmitted signals. No operation can be performed until verification is received and the master "operate" key switch is operated. The proof-of-operation (return indication) comes back automatically within 3 seconds of actual operation.

Two groups of 10 pulses will provide 99 functions (on-off for 48 breakers) and 3 groups of 10 pulses will provide 999 functions (on-off for 499 breakers) all over a single telegraph grade (0-15 cps) channel. This system may be used over regular audio channels in order to obtain the maximum usage of each audio channel.

Time duration telemetering can be used over the same channel. When the channel is needed for control, return indications or alarms, the PS '56 takes over.

R. H. Nichols Ltd., Toronto.

Low power transformer 111

This new series of low-voltage, high-current transformers designated type 210, is designed for use with a compatible choke, and silicon, selenium or germanium rectifiers to provide dc power. It is available in seven ratings ranging from 7 volts ac at 2 amperes, to 37 volts ac at 10 amp.

Hammond Mfg. Co. Ltd., Guelph, Ont.

Multispeed tape recorder 112

The purpose of the model TRV-8 multispeed tape recorder is to provide means for recording and play-back of information on magnetic tape in a wide range of speeds, with the provision that information recorded at one of the available speeds can be played back immediately at another speed through the resetting of a single tape speed control knob.

TRV-8 is composed of three interrelated packages: tape take-up and rewind deck, multispeed gear box and capstan shaft drive, electronic unit. Tape speeds are 1.5, 2.0, 2.75, 3.75, 5.5, 7.5, 11.0, 15.0 ips. Main drive motor is a three-speed synchronous hysteresis motor, a four-step idler speed box comprising pull-in solenoids, microswitch control and sensing unit, four floating idler wheel arrangement, step pulley and flywheel.

Presentey Engineering Products Ltd., Ottawa.

Silicone rubbers 113

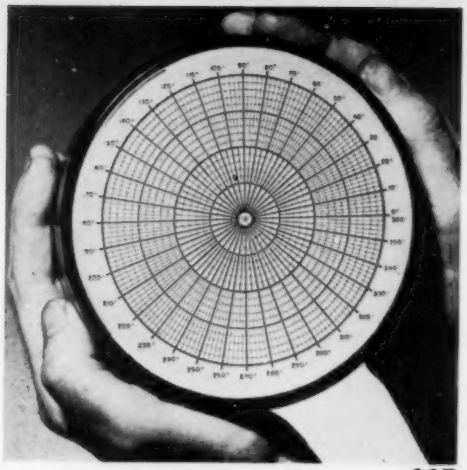
Two new RTV (room-temperature vulcanizing) silicone rubbers have been introduced for such applications as void filling, cushioning and vibration damping. Identified as RTV-120 and RTV-160, they will cure at room temperature in a few minutes to form a resilient, silicone rubber sponge. RTV-160 is designed for applications requiring somewhat greater resiliency than offered by RTV-120. Pot life and sponge properties of each compound, however, may be varied to meet the particular application.

Canadian General Electric Co. Ltd., Toronto.

Improved audio tube 114

A new improved version of the 12AX7 tube is now on the market. Registered as 7025A/12AX7A, this tube offers superior characteristics to the 12AX7, 7025 and ECC83, for hi fi and critical audio applications. The tube was developed to meet the need for extremely low hum and microphonic levels in high-gain, wide-range amplifiers. The substantial improvement in microphonic rating has been achieved through use of triple mica supports, mounting of the cathodes under tension for extra rigidity, and improved mica design with much closer tolerances.

Canadian General Electric Co. Ltd., Toronto.



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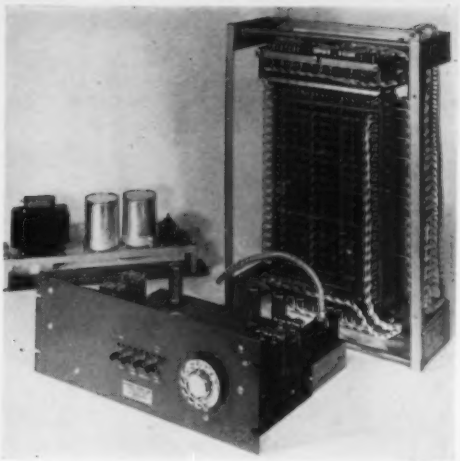

120

CRT face plate scales 115

A simplified, inexpensive method of applying black-scale patterns on the inside of the face plate of cathode-ray tubes is reported by Allen B. Du Mont Laboratories Inc. Engineering models of tubes of this type have been made and the company states that it is feasible to apply the process to production quantities of tubes. The substance used in the process is a special glass which has been milled to a very small particle size and subsequently reduced in hydrogen. This produces a black glass powder which is further refined to disintegrate agglomerates. It may be photoprinted into the desired scale or pattern onto the inside of the tube face.

Allen B. Du Mont Laboratories Inc., Clifton, N.J.

Double pulse generator 116

Nagard wide range delayed double pulse generator type 5002 was designed to meet the need for a generator of fast-rising pulses and square waves, while at the same time providing a wide range of amplitude, repetition rate, width and delay with direct-reading calibrations. The instrument has two output circuits. The main output consists of either a single or double pulse of either polarity and of controllable amplitude calibrated to ±2%. The rise time is independent of width throughout the ten million to one range available.

Main pulse width is 0.2 usec to 2 sec; delay from prepulse or between pairs of double pulses is 0.2 usec to 2 sec; internal oscillator is 0.1 cps to 1 mc; rise time (20 mv to 2 volts) is approximately 0.01 usec negative or 0.015 usec positive.

Electrodesign, Toronto.

Machine tool control 117

Two new developments in the machine tool control field have just been announced. The first is a fully transistorized continuous path control system with a maximum machining time of 160 minutes. It employs an electro-optical measuring system and hydraulic piston motors controlled by electro-hydraulic valves.

The second system also fully transistorized, is designed for rapid point-to-point positioning and operation of machine tools such as drilling machines. Information is presented to the control console in the form of puched paper tape which can be prepared by the machine tool operator. Incremental movements can be accomplished by direct dial setting without using tape. Feedback checking and monitoring is from electro-optical measuring scales.

Ferranti - Packard Electric Ltd., Toronto.

Subminiature pulse transformer 118

Micro-Stat pulse transformers feature clamped ferrite core construction in the typical CI configuration. Use of core-gapped construction instead of the conventional toroid and cup core provides improved voltage breakdown and insulation resistance. The design also features faster reset and less Br, higher power capabilities, lower losses, and increased total flux swing capability.

Pulse Engineering Inc., Santa Clara, Cal.

Wamoscope tube 119

Wamoscope, a cathode ray tube capable of presenting microwave frequency information directly on its screen, has been developed for use in advanced electronic systems applications. It does not require any external focusing solenoid. It operates over a frequency range of 2 to 10 kmc, and will be particularly important in high-resolution radar applications. It exhibits a resolution of 160 lines per inch at the centre of its screen. The signal coupler is incorporated within the neck of the tube envelope. It was developed by Sylvania Electric Products Inc.

Hackbusch Electronics Ltd., Toronto.

Self-stepping crossbar scanner 120

Developed as a portable, high-capacity pilot plant or laboratory testing device, model SC-5F is a modified type F crossbar switch with simplified drive circuitry enabling it to connect sequentially a six-wire circuit to each of 100 sets of six-wire terminals at up to 50 sets per second. The six wires can be further divided into single, double, and three-wire circuits. Because of its twin gold contacts with 30 gram minimum contact pressure which permits scanning of low-level signals, it is readily adaptable for thermocouple and strain-gauge scanning.

The scanner has a bridging capacity of 20 uufd to ground and between conductors. Breakdown voltage is not less than 1,500 vac between switching conductors and frame and across switching contacts. Insulation resistance is 10,000 megohms and higher. Conductor resistance through longest path is 0.3 ohms. Current carrying capacity is 100 milliamps noninductive at 50 vdc for 20 million operations. Contact bounce is less than 200 usec on make and none on break.

James Cunningham Son & Co., Inc., Rochester, N.Y.

Solderless coaxial plugs 121

CRIMPEE is a solderless RF coaxial plug using a simplified crimping method for high speed assembly. It is readily interchangeable with military PL-259 plugs and mates with the SO-239. It is available for five cable sizes: RG-8/U, 9/U, 11/U, 58/U, and 59/U. It can be assembled in minutes by crimping the cable braid between two concentric ferrules, which are placed over the cable jacket. This operation may be performed with the aid of a crimping tool, specially designed for this plug. Laboratory tests have shown it capable of withstanding pulling force in excess of 100 lb.

Cannon Electric Canada Ltd., Toronto.

(Continued on page 50)

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New products—cont.

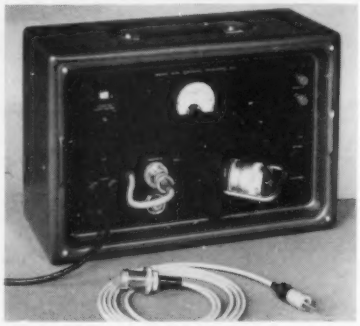
Signal generator 122

Trad signal generator model SG-54 features low incidental fm content and is designed for field and laboratory use. It covers the frequency range 4 to 420 mc in 6 bonds and is equipped with an accurately calibrated attenuator.

Male Sales Ltd., Toronto.

Electronic micrometer 123

Wayne Kerr electronic micrometer model B721 is designed to measure accurately distances in the range of 0-45,000 micro-inches. It employes a non-contacting capacitance probe.

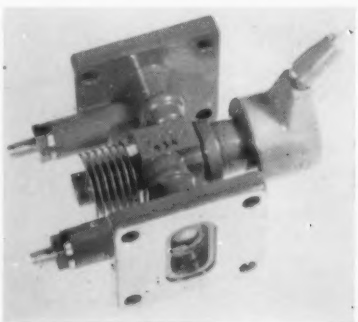


The Glendon Instrument Co. Ltd., Toronto.

Amplifier klystron 124

To meet requirements of an air-borne, rugged medium-power micro-wave amplifier, a new design for a two-cavity klystron has been developed which features capacitive external tuning. Designated type VA-824, it has mid-band saturation outputs of 5 watts that obtain mean power gains up to 10 db. Tubes may be used in continuous or pulse modulated amplification, or for synchrodyne or serrodyne frequency shifting.

Varian Associates of Canada Ltd., Georgetown, Ont.



Radar display tubes 125

Three new radar display tubes, types 10WP7A, 10KP7B, and 12ABP7A have been introduced. With the exception of the 10KP7B, the tubes are electrostatic focus, magnetic deflection.

The 10KP7B is a 10-in. magnetic-focus, magnetic-deflection, long persistence radar display tube of round-glass construction. This tube features a metal-backed screen to improve light output, prevent ion spot blemish, and reduce undesirable screen charging. The faceplate is made of neutral gray glass to minimize reflections and improve contrast. In addition, the tube employs an improved resolution electron gun.

The 10WP7A has an aluminized screen for increased brightness and has a no-ion-trap gun. The gun features improved resolution capabilities.

Employing a low-voltage electrostatic focus giving high definition, the 12ABP7A is a 12-inch round display tube which has a metal-backed screen for improved contrast and greater light output. This tube employs a low-voltage electrostatic focus gun having high definition. The faceplate is of gray-filter glass.

Canadian Westinghouse Co. Ltd., Hamilton.

L band signal generator 126

Winston L band signal generator type 957 covers the 800 to 2,100 mc band in one directly calibrated range. It provides a source of cw or pulse-amplitude-modulated power for the measurement of radio receiver characteristics. Power output is 0 to —100 db continuously adjustable by a directly calibrated control relative to 1 mw. Absolute accuracy of reading is ±2 db with relative accuracy of ±0.2 db. Power is monitored by a temperature compensated thermistor bridge operating a panel meter. Facilities are provided for external frequency modulation.

Mechron Engineering Products Ltd., Ottawa.

Diode has fast recovery time 127

Miniature silicon junction computer diode model MA-4223, designed by Microwave Associates Inc. features fast recovery time. When switched from the forward bias with 10 milliamps current flowing to the reverse bias of —5 volts, the complete recovery time is 4 millimicroseconds maximum. Forward current (steady state dc) is 50 ma dc; peak surge current (1 sec.) is 100 ma dc; reverse voltage (steady state dc) is 30 vdc; power dissipation is 100 mw.

E. G. Lomas, Ottawa.

Direct reading gaussmeter 128

Operating on the Hall effect, the model 100 gaussmeter uses as its sensing element a thin wafer of high-purity indium arsenide with a temperature coefficient of 0.1%. The smallness of this element (0.019 in. thick and 0.125 in. wide) permits insertion of the flat probe tip into very narrow air gaps. The active area of the sensing element is equal to a circle of 0.0625 in. diameter. High gradient fields can thus be measured easily in confined spaces. The sensing element is

non-magnetic and does not disturb the field being measured.

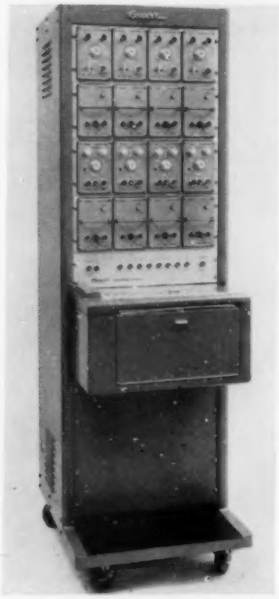
A convenient scale selector on the front panel gives gauss readings in 3 scales: 0 to 300, 0 to 3,000 and 0 to 30,000 gauss. The instrument will read dc flux in the presence of a strong ac field, as long as the probe is held in a constant magnetic field.

F. W. Bell Inc., Columbus, O.

Modular recording system 129

Epsco modular recording system is a flexible rack-mounted system offering a choice of five interchangeable pre-amplifiers with sensitivities as low as 10 microvolts. It offers up to 8 channnels of recorded information.

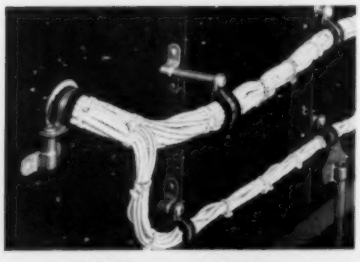
A. C. Wickman Ltd., Toronto.



Self-locking fasteners 130

Two new types of one-piece right-angle self-locking fasteners have been designed for attachment of instrument panels, shock mounting of delicate equipment, tubing and wiring harness, etc. They are suitable for medium to light loads, are made of aluminum alloy, and are made in the form of impact extrusions or forgings. The fasteners incorporate both self-locking device and mounting bracket in one unit.

Western Sky Industries, Hayward, Cal.



(Continued on page 53)

INTRODUCING THE SIGMA MODELS FOR 1960

Total newness is only one of the exciting features of these 1960 Sigma relays. Eager in performance, nimbly darting around the worst circuit parameters, they bring back that forgotten thrill of the first time you got a relay to work in a circuit — and they win the respectful admiration of all your electronic colleagues. No matter what your reason for owning a relay, there's a new Sigma model — standard luxury or fully equipped — to make every magnetic excursion fun again!

All 1960 models come with coils wound with genuine wire, potentially movable armatures, and 100% fresh magnetic fields created by Sigma master craftsmen, at no additional cost. (Models illustrated include optional extras available at added cost — ohm grown resistance values, dry circuit quencher and Braintree Beige enclosures.)

Decide now to be unhappy with anything less than a 1960 Sigma relay. Make your status clear — fulfill your desire to be known as one who dares to be different . . . one who uses Sigma relays. And always remember: when better relays are built, Buick will build them.

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Frequency bridge

The Muirhead D-101-C Frequency Bridge employs the Wien Bridge circuit providing a satisfactory and simple means of measuring audio frequencies, from 100 c/s to 12,100 c/s in two ranges selected by a switch. Measurements to an accuracy ±0·25% are made by means of two decade dials and a continuously variable direct reading dial permitting interpolation between adjacent steps on the second decade. The reading accuracy is always better than 0·05%. The bridge is assembled on a standard panel for rack mounting, provision being made for both jack and binding post connexions.

391

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Defence contracts

Unclassified electronics contracts for $10,000 or more have been awarded to the following Canadian firms by the Department of Defence Production. A figure in parenthesis indicates the number of contracts, the amount being the total value.

August 16-31, 1959

Aviation Electric Ltd., Montreal, vehicular navigation aid, $90,921; spares for aircraft instruments, $12,-968.

Bayly Engineering Ltd., Ottawa, signal generators, $43,559.

Campbell Mfg. Co. Ltd., Willowdale, Ont., components, $10,495.

Canada Wire & Cable Co. Ltd., Ottawa, electrical cable, $11,575.

Canadian Marconi Co., Montreal, technical studies, $10,958; establishment of facilities for manufacture of magnetrons and traveling wave tubes, $730,500 (3).

Canadian Pacific Railway Co., Ottawa, rental of teletype facilities, $16,000.

Collins Radio Co. of Canada Ltd., Toronto, components, $100,986; test equipment, $17,060.

Computing Devices of Canada Ltd., Ottawa, components, $13,232; equipment, $25,000; spares for aircraft instruments, $171,345.

Federal Wire & Cable Co. Ltd., Guelph, Ont., electrical cable, $17,149.

Ferranti-Packard Electric Co. Ltd., Toronto, salvage and rework of artificial horizons, $114,000; repair and overhaul of artificial horizons, $194,-100.

Anthony Foster & Sons Ltd., Toronto, equipment, $59,154.

Millard Electric Ltd., Perth, Ont., antenna mast kits, $11,880.

Northern Electric Co. Ltd., Montreal, equipment, $11,053; telephone cable, $11,174.

Picker X-Ray Engineering Ltd., Montreal, medical x-ray equipment, $12,590.

Technical Enterprises Ltd., Montreal, test equipment, $34,799.

Telecables & Wires Ltd., Ottawa, telephone cable, $34,482.

September 1-15, 1959

Amalgamated Electric Corp. Ltd., Ottawa, radiac equipment, $348,599.

Canadian Aviation Electronics Ltd., Montreal, repair and overhaul of flight simulators and twin engine flight procedure trainers, $10,000.

Canadian General Electric Co. Ltd., Toronto, mod. kits, $61,286 (2).

Canadian Marconi Co., Montreal, tubes, $15,600; oscillator, $12,576.

E. M. I. - Cossor Electronics Ltd., Halifax, repair and overhaul of ground and airborne materiel, $10,000.

Instronics Ltd., Stittsville, Ont., signal generators, $40,330.

Philips Electronics Industries Ltd., Toronto, equipment, $15,809; spares for radio sets, $14,305.

New products—cont.

Paper tape editing console 131

This tape preparation and editing console automatically verifies and duplicates paper tapes. It consists of a numerical keyboard, a control and comparison section with 6-digit decimal readout, two tape readers and one tape perforator. Key features are tape-to-tape duplication and verfication at 60 characters per second; keyboard visual display and shift register to eliminate copying errors; automatic error alarm and tape corrections without over-punching or splicing.

Tape may be produced in several modes from source data entered at the keyboard. Or it may be reproduced directly from a master tape placed in one of the readers. Tape verification is accomplished either through keyboard data re-entry or through comparison of tapes in the two read stations. Comparison is automatic within the console. The unit accepts standard tape widths of 0.687, 0.875 and 1.000 inches. Adjustments for other sizes can be made in the field.

Tally Register Corp., Seattle, Wash.

Pull-push switches 132

Two new 13/16-in. diameter pull-push switches in separately mounted styles have been introduced. Type SK-1 has 8-17 ounces actuating force with a 3 amp 125 vac UL rating. Type S-MK has under 6 ounces actuating force and a UL rating of 1 amp 125 vac. Shaft travel is 5/32 in. ± 1/64 in., shaft diameters 0.250 in. and 0.187 in. A variety of shaft lengths and styles plus mounting bushings are available.

C. C. Meredith & Co. Ltd., Streetsville, Ont.

(Continued on page 55)

RAYTHEON®

RAYTHEON CANADA LIMITED awarded top honours at Canadian I.R.E. Show

The award for the most outstanding new Canadian development exhibited at the I.R.E. Canadian Convention, 1959 was presented to Raytheon Canada Limited for their ★new Radar to TV scan converter for bright display systems. This makes it possible to read at a glance both the present and past position of radar targets on a TV monitor in a lighted room or in daylight.

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Nuclear research and development centre to be built in Manitoba

The Hon. Gordon Churchill, Minister of Trade and Commerce, has announced that Atomic Energy of Canada Ltd. (AECL) will build a new nuclear energy research and development centre in Manitoba.

Preliminary discussions have been held with the Government of Manitoba and it is expected that site surveys will be carried out in Manitoba within the next few months and a site selected by early 1960.

Over the next twenty-five years the research and development effort in the field of nuclear energy must expand if Canada is to maintain its position as one of the leading atomic energy nations. During this period several major research and development facilities will have to be built. The directors and management of AECL recommended to the federal government that to permit the Chalk River centre to operate at its maximum efficiency the centre should not continue to expand.

Construction of buildings and laboratories, and the installation of equipment and technical services at the Manitoba site will begin with the next major project to be undertaken by AECL in the research and development field. This may be an organic-cooled, natural uranium-fueled, heavy-water-moderated power reactor experiment in about two years' time.

Atomic Energy of Canada opens reactor school

The wide interest shown in the atomic power systems being developed in Canada has prompted Atomic Energy of Canada Ltd. (AECL) to establish a reactor school at Chalk River, Ont. First class will begin February 1, 1960.

Canadian and foreign engineers and scientists may apply for admission to the school, which will have a class of 20 students in each 12-week course.

The course of studies places special emphasis on power reactors moderated with heavy water and fuelled with natural uranium. Chalk River Reactor School will not duplicate instruction being given by universities. Candidates must have a universty degree in physics, engineering physics, chemistry, metallurgy, or engineering. They will receive the basic instruction required for a thorough understanding of the design, construction and operation of nuclear reactors.

Application forms may be obtained from Canadian embassies or consulates or from the Secretary, Chalk River Reactor School, Atomic Energy of Canada Ltd., Chalk River, Ontario.

AECL signs technical agreement with Euratom

J. L. Gray, president of Atomic Energy of Canada Ltd. (AECL), signed a technical agreement on October 6 between AECL and the European Atomic Energy Community (Euratom). General nature of the bilateral agreement is to carry out a joint research and development program centred on the heavy-water-moderated type of reactor. Work will be carried out both in Canada and within Euratom, with exchange of information. A joint advisory board will be established to guide the programs.

The six Euratom countries are France, the Federal Republic of Germany, Italy and the Benelux countries.

1960 atomic exposition now being assembled

Floor space for the 1960 atomic exposition, to be held in the New York coliseum on April 4-7, is now available. The exposition will be held in conjunction with the 1960 Nuclear Congress. It is sponsored by 28 engineering, management and industrial organizations.

British design new thermo-nuclear research machine

British scientists feel they were so close to obtaining a thermo-nuclear reaction with ZETA they have decided to go ahead with construction of another machine. ICSE (Intermediate Current Stability Experiment) will be larger than ZETA and, it is expected, overcome many of the instability and other problems met with ZETA.

International directory of radioisotopes

First volume of the "International Directory of Radioisotopes — Unprocessed and Processed Radioisotope Preparations and Special Radiation Sources", has been published by International Atomic Energy Agency, Vienna. (Price: $3.50, U.S. currency.) It contains information on all radioisotopes which are for sale or distribution by the 59 major suppliers in the world.

Volume 2 will follow shortly (price: $3.00, U.S. currency).

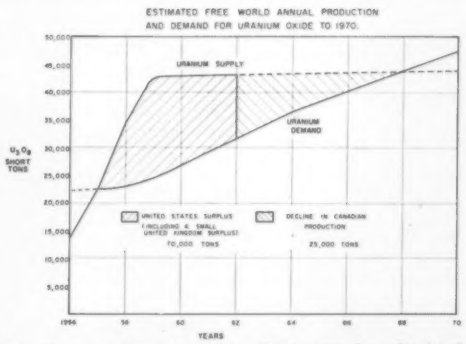
Photographs show presence of anti-matter

Photographs exhibiting the presence of particles of anti-matter called anti-lambdas, have been taken in the new six-foot bubble chamber at the University of California's Lawrence Radiation Laboratory.

The nuclear particles, generated in bombardments by the bevatron, have been photographed by a group headed by Dr. Luis W. Alvarez, professor of physics and associate director of the laboratory.

The photograph is the second record of a nuclear event involving an anti-lambda, but the first record of the complete reaction containing the anti-lambda, and the particles which started the chain of events.

The anti-lambda belongs to a species of particles called hyperons. It has a mass of 2,180 electron masses. It has no electrical charge. There is only one member of the lambda species, the ordinary lambda, which is also neutral in charge.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URANIUM SUPPLY
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UNITED STATES SURPLUS (INCLUDING A SMALL UNITED KINGDOM SURPLUS)
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DECLINE IN CANADIAN PRODUCTION
25,000 TONS
YEARS

Uranium exports in 1958 amounted to 5.7% of all Canadian exports. The present world surplus, however, will reduce these markets, but there are brighter prospects on the long-term basis as the demand for uranium increases. Full details are carried in "Uranium in the western world" by S. W. Clarkson, publication AECL No. 858. This may be obtained from the Scientific Document Distribution Office, Atomic Energy of Canada Ltd., Chalk River, Ontario. Price: $1.50.

GRADUATE ELECTRONIC ENGINEERS or ENGINEERING PHYSICISTS for Atomic Energy Research

For developing techniques and instruments to study nuclear reactor fuel elements, by non-destructive methods, such as eddy-current and ultrasonic testing.

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Post-graduate training an asset for either post.

Modern fringe benefits—single accommodation in staff residence in Deep River, a planned community on the Ottawa River.

State all particulars in first letter to

File 10 A
ATOMIC ENERGY OF CANADA LIMITED
Chalk River, Ontario

ENGINEERS AND PHYSICISTS

Vacancies exist for several graduate engineers and physicists at Canadian Marconi Company's tube operation in Montreal. The Company is expanding its activities in the fields of research, development, engineering design, and production of microwave tubes.

Positions of junior, intermediate and senior levels are to be filled. Previous experience is desirable either in vacuum physics, in electronic tube or microwave engineering, or, for one vacancy, in pulse modulator design.

Substantial starting salaries will be paid to suitable appplicants. Excellent working conditions. 37½ hour work week. All usual employee benefits. Interviews will be arranged promptly. All replies will be treated on a confidential basis.

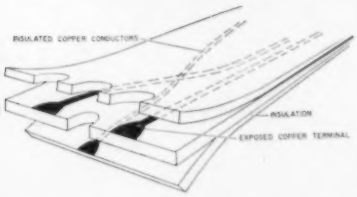
Send résumé showing educational background and previous experience to:

Canadian Marconi Company,
Industrial Relations Division,
2442 Trenton Avenue,
Montreal 16, P.Q.

New products—cont.

Flexible etched circuitry 133

This custom-designed flexible etched circuitry is available in any production



quantity. Conductors are embedded between 2 sheets of thermo plastic that have been fused into one homogeneous mass, eliminating many environmental problems such as salt spray, polarization, and oxidation.

IRC Resistors, Toronto.

Laboratory power supply 134

Electronic Controls Ltd. power supply model EC1031 is designed for high school laboratory use. Virtually tamper proof, it has four separate outputs available. The binding post terminals deliver either 0-24 vac or 0-24 vdc at 10% ripple. Maximum current rating is 10 amp. This circuit is protected by an automatic reset thermal breaker. The duplex receptacle provides a convenience outlet for line voltage or 0-140 vac from the variable transformer.

Douglas Randall Canada, Ltd., Toronto and McIntyre Agencies, Montreal.

Permanent magnet material 135

Alnico VII A, a new permanent magnet material with an energy value of 2.8 million oriented, is now being produced for use in magnetic core meter and instrument applications. It is exhibits a coercive force (Hc) considerably higher than other materials in the Alnico family. For this reason, it resists demagnetization even when subjected to high environmental heat often associated with core meters. It is a hard-brittle material suitable for grinding and can be supplied oriented or not oriented.

The Indiana Steel Products Co. of Canada Ltd., Kitchener, Ont.

Frequency standard 136

This one megacycle stable oscillator is fully transistorized and has been designed as a frequency standard which, when combined with transistorized frequency divider circuits, provides a compact frequency source. It has maximum application in equipment where a frequency or timing accuracy of 1 part in 10^7 is required. With dividing chains it can provide this accuracy in the range of a few cycles to 1mc and is suitable as the master timing clock for data handling.

Stability is 1/10 cycle per day over ambient extremes of —40 deg F to +124 deg F.

RCA Victor Co. Ltd., Montreal.

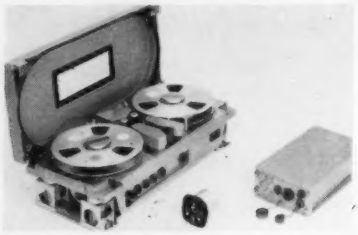
(Continued on page 56)

New products—con't.

Airborne recorder 137

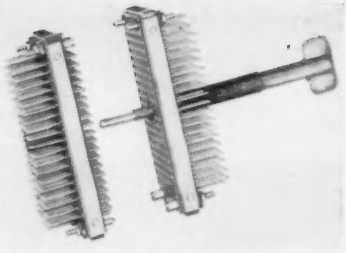
Miniature tape recorder model AR-200 has been designed for data acquisition in airborne applications. It consists of three units — tape handling capsule, control mechanism, and electronic circuits. Semiconductors are used throughout.

Ampex American Corp., Toronto.



Connector has screwlock 138

DeJur-Amsco Corp. have introduced Series 1900 miniature rectangular power connectors with centre screwlock and closed entry contacts. These pin and socket connectors are designed for heavy-duty applications in electronic equipment. They have high dielectric and mechanical strength, and feature stainless-steel channels which are riveted to the long sides of plug and receptacle.



A double lead thread action centre screwlock assures positive locking action of mating units. Terminals for solderless wire wrap, solderless taper pin or solder cup are available. This series can be supplied with 152, 104, 78 or 34 contacts.

Atlas Radio Corp. Ltd., Toronto.

Secondary frequency standard 139

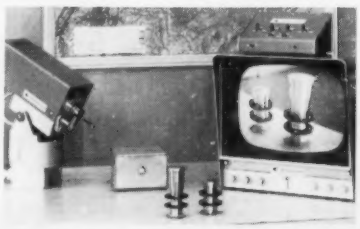
Crystal-controlled time/frequency calibrator, type 1213-D, has a short-time stability of 1 part in 10^7. It furnishes standard frequencies from 10 kc to 1,000 mc and also provides timing markers at decade intervals from 0.1 to 100 usec. An internal crystal oscillator — using a 5 mc AT-cut hermetically sealed quartz plate—is electron coupled to a 2:1 multiplier, followed by a 10 mc buffer stage which drives a series of multivibrators with fundamentals of 1 mc, 100 and 10 kc. Generated harmonics can be mixed with an incoming signal in the internal crystal mixer or fed to other equipment through a coaxial (50 ohm) line. Audio amplification is provided for the beat frequencies thus produced, and video amplification is available for the timing-marker signals.

General Radio Co., Toronto.

Closed circuit television 140

TelAutovision has been designed for industrial, business and institutional applications. It has a resolution of 600 lines and is available with remote camera control for pan, tilt, zoom, iris and focus. The system can be leased or bought outright.

Automatic Electric Sales (Canada) Ltd., Toronto.



Megacycle Meter

Model 59 Oscillator 2.2 Mc - 420 Mc

Model 59-UHF Oscillator 420 Mc - 940 Mc

Model 59-LF Oscillator 100 Kc - 4.5 Mc

Determines resonant frequency of tuned circuits, antennas, transmission lines, by-pass condensers, chokes, etc. Measures inductance and capacitance. Also used as a signal generator, wave meter, frequency meter, and in many other applications.

This compact, lightweight grid-dip meter is available in the frequency ranges indicated.

Laboratory Standards

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BOONTON, NEW JERSEY

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company_____

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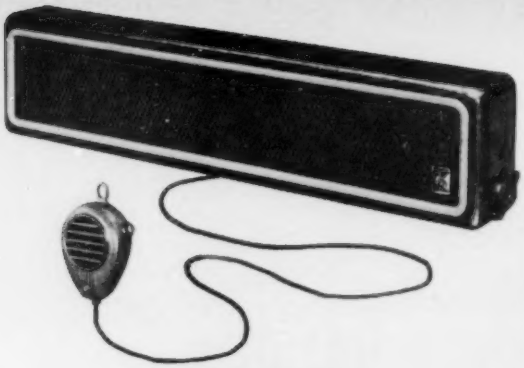

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A completely self-contained portable P.A. System. Fully transistorized and operated by standard flashlight cells.

Suitable for escorted plant tours, presentation ceremonies, group instruction, sectional announcements.

Unit has four built-in speakers with a three-watt amplifier, plug-in, hand held microphone.

For further details, write:

PAYETTE RADIO LTD.

730 St. James W., Montreal
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Pylon static converters Type CX-48, connected as main and automatic standby generators, provide a dependable source of 24V and 130V battery power at locations equipped with 48V battery. Capacity to be built up as required.

Write for information on Pylon static converters and 60 c/s inverters for communications service.

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PYLON ELECTRONIC DEVELOPMENT company, ltd.

Communications Systems and Equipment

161 CLEMENT ST., LASALLE, MONTREAL 32, QUE.

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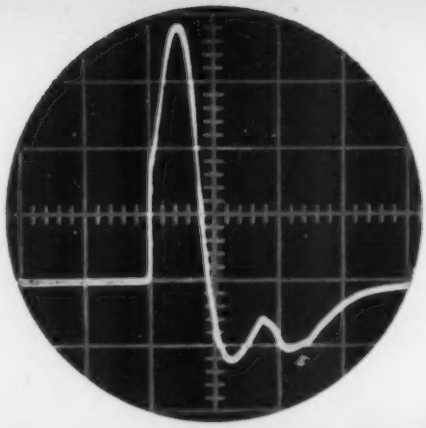

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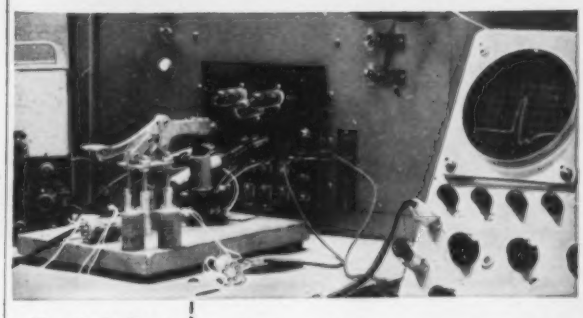
PULSE TRANSFORMERS



Test jig duplicating actual conditions the transformer will meet in service.

1

2

3

1. 0.65 μs Sec.
2. 0.6 μs Sec.
3. 0.5 to 2 μs Sec.

Strict conformation to mechanical and electrical specification is ensured by 100% inspection.
Each Hammond Transformer is individually tested under working conditions in a duplicate of the circuit in which it will be used.

These bulletins are available on request!

4650	3 Phase Special Open Frame Transformers
5023	JCNAAF-T-19, MIL-T-27A
5057	Saturable Core Reactors
5060	Consoles
5100	Variable Condensers
5106	Miniature Transistor Mounting Dimensions
5202/03	Stock Transistor Transformers

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HAMMOND MANUFACTURING COMPANY LIMITED

H/10 GUELPH ONTARIO CANADA

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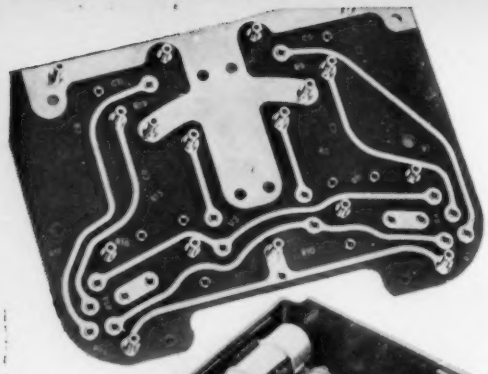

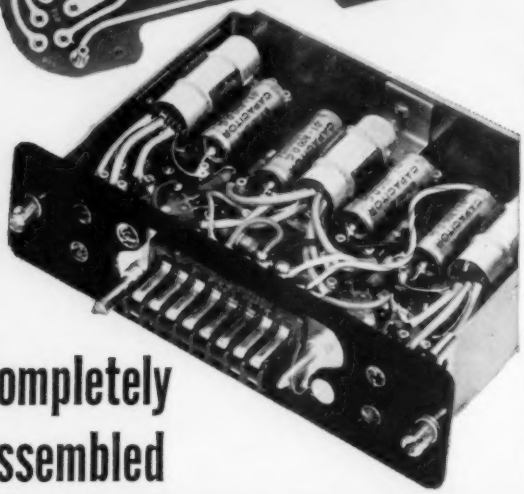

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- dip or hand soldered
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- completely tested

United-Carr produces reliable Printed Wiring Boards and Complete Assemblies for commercial and military applications. Assembled units such as the 400 cycle amplifier above are produced to customer specification.

These newer services are a development of many years' experience in the manufacture of tube sockets, connectors, terminal strips, dial light sockets, wired assemblies and specialty electronic components.

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UNITED-CARR FASTENER COMPANY OF CANADA LIMITED

231 Gage Avenue North, Hamilton, Ontario

Sales Offices: Hamilton, Toronto, Montreal

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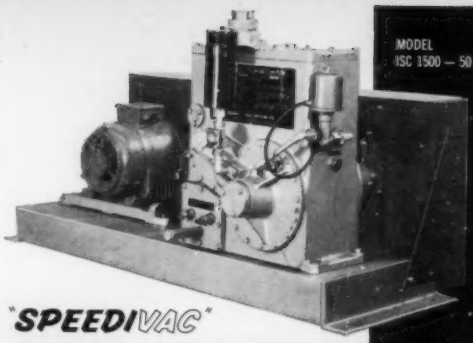

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Dozens of applications: chemical processing, distillation, impregnation, metallurgy, etc. Send for information

EDWARDS HIGH VACUUM (CANADA) LTD.

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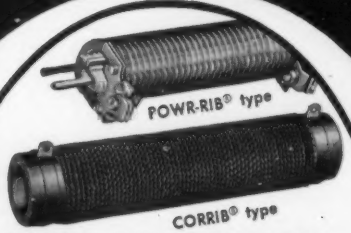

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OHMITE Manufacturing Co.
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HUGHES
SEMICONDUCTORS
NOW STOCKED IN CANADA

R-O-R now stocks a range of the most popular Hughes silicon and germanium diodes, voltage variable capacitors and parametric diodes.

TYPES STOCKED INCLUDE

Germanium Diodes	Voltage Variable Caps.	Silicon Diodes
1N67A	HC 7001	1N456
1N68A	HC 7004	457
1N96		458
1N100A	**Parametric Diodes**	459
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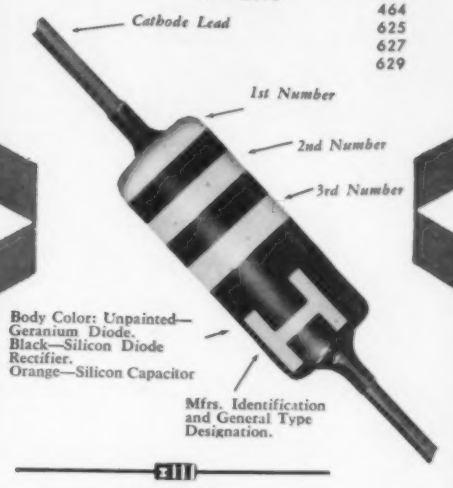

Actual Size

All types are identified by three colored bands on the cathode end, in keeping with the proposed EIA standard for color-coding semiconductor devices. These bands of color designate the type number. In addition to the three bands, the letter "H" is printed on the body to indicate the name of the manufacturer. The color of the letter "H" also has significance, as indicated in the following table.

Gold	EIA	**Brown**	Rectifier
White	Special	**Black**	Capacitor

HUGHES INTERNATIONAL
A DIVISION OF HUGHES AIRCRAFT COMPANY, U. S. A.

R O R

The styles listed represent a wide range of performance parameters — however Hughes has **thousands** of semiconductor types to fit particular applications. Contact R-O-R for engineering details, current prices and data sheets.

R-O-R ASSOCIATES LIMITED
1470 DON MILLS RD., DON MILLS, ONT.

TORONTO HIckory 4-4429 — TELEPHONE — MONTREAL HUnter 1-0700

For further information mark No. 39 on Readers' Service Card

CBC tv film will show impact of electronics on daily life

"This Electronic World" is the title of a 30-minute film which will be shown on the CBC television network on Sunday, November 8 at 5.30 p.m. It is a National Film Board production, reporting the impact of electronics on the lives of ordinary people.

Dr. E. W. Leaver, president of Electronics Associates Limited, Toronto, is the commentator in the film.

In the opening sequences, the film shows rockets blasting off from Fort Churchill, robot machines controlling the production of railway carriage wheels and a television unit being used for a large-screen, closed-circuit demonstration of medical techniques at a doctors' convention.

Animation photography is used to explain direct distance dialing. Mrs. Helen Crossey, of Verdun, Quebec, who works as an interior designer of ships, tells how her work takes her to many parts of the world, and how dependable navigational aids like ADF, VOR, LORAN and I.L.S. help airlines keep planes flying on schedule.

One of the most appealing sequences in the film shows how tiny transistorized inductive look receivers make it possible to teach deaf children. As a result of this electronic help, these handicapped children are almost as advanced in their studies as their colleagues with normal hearing.

The photograph shows work being done at Toronto's Sunnyview School.

"This Electronic World" will be available early next year, for 16mm showings to clubs, organizations, etc. National Film Board offices and local film libraries throughout Canada will have information about the availability of prints after January 15, 1960.

Dates set for hearings on broadcast

The Board of Broadcast Governors has announced dates for public hearings in the first half of 1960, and deadlines for submissions of briefs to the Department of Transport.

Location	Hearing opening 1960	Application deadline 1959
Winnipeg	Jan. 11	Oct. 30
Vancouver	Jan. 18	Oct. 30
Montreal	Mar. 7	Nov. 30
Toronto	Mar. 14	Dec. 31
Edmonton, then Calgary	May 9	Feb. 29 1960
Halifax, then Ottawa	June 20	Mar. 31

Applications for second television licenses will be heard at the various cities listed. In addition, applications for new am or fm stations, increases in power, television stations in areas not now served, etc., will be heard.

IRE sections open new season

The **Toronto Section of IRE** held its first meeting of the season on Sept. 21. Mr. Tony Jamroz, P.Eng., of Northern Electric Co. Ltd., Belleville, Ont., discussed present techniques in stereophonic reproduction. He demonstrated a three-speaker system and a newly developed single stereophonic microphone. A tape recording was played which compared single and double microphone recordings.

Jamroz and Eastwood

In true stereo style, a second speaker was used at this meeting. C. Eastwood, P.Eng., of radio station CFRB outlined 23 proposed am, fm and tv stereophonic systems.

On November 23 the section will tour Radio Valve Co. Ltd., Rexdale, Ont., to see the latest techniques in the manufacture of cathode ray tubes.

South-Western Ontario Sub-Section held its first meeting October 20 in Windsor. J. Allen of K.L.A. Laboratories, Detroit, covered the development of sound recording and reproducing techniques from the early days of Edison to present day stereophonic reproduction. He included a stereophonic demonstration.

COMING EVENTS

November

9-11 EIA-IRE Radio Fall Meeting, Syracuse, N.Y.

10-12 Twelfth Annual Electrical Techniques in Medicine and Biology Conference. Philadelphia, Pa.

17-19 Northeast Electronics Research and Engineering Meeting. Boston, Mass.

25-28 International Radio Hobbies Exhibition. London, England.

January 1960

25-29 Stress Measurement Symposium, Arizona State University, Tempe, Arizona.

February

3-5 IRE-PGMIL winter meeting, Los Angeles, Calif.

19-23 Third International Exhibition of Electronics Components. Paris, France.

March

21-24 Radio Engineering Show and IRE National Convention, New York.

Microwave communications

Increasing attention is being focused by communications and other companies on the use of microwave radio relay equipment. The applications for such equipment are changing rapidly and many new techniques and components are being used in the various systems now available.

To bring its readers up to date, CEE is devoting the December issue to a discussion of microwave systems; their requirements, ancillary equipment, (emergency power, towers, passive repeaters, buildings, etc.), and a comprehensive comparison of published performance figures.

NOW!

Constant output level

Constant modulation level

3 volt output into 50 ohms

Low envelope distortion

50kc TO 65MC

New -*hp*- 606A HF Signal Generator

Here at last is a compact, convenient, moderately-priced signal generator providing constant output and constant modulation level plus high output from 50 kc to 65 MC. Tedious, error-producing resetting of output level and percent modulation are eliminated.

Covering the high frequency spectrum, (which includes the 30 and 60 MC radar IF bands) the new hp 606A is exceptionally useful in driving bridges, antennas and filters, and measuring gain, selectivity and image rejection of receivers and IF circuits.

Output is constant within ±1 db over the full frequency range, and is adjustable from +20 dbm (3 volts rms) to —110 dbm (0.1 μv rms). No level adjustments are required during operation.

SPECIFICATIONS

Frequency Range: 50 kc to 65 MC in 6 bands.

Frequency Accuracy: Within ±1%.

Frequency Calibrator: Crystal oscillator provides check points at 100 kc and 1 MC intervals accurate within 0.01% from 0° to 50° C.

RF Output Level: Continuously adjustable from 0.1 μv to 3 volts into a 50 ohm resistive load. Calibration is in volts and dbm (0 dbm is 1 milliwatt).

Output Accuracy: Within ±1 db into 50 ohm resistive load.

Frequency Response: Within ±1 db into 50 ohm resistive load over entire frequency range at any output level setting.

Output Impedance: 50 ohms, SWR less than 1.1:1 at 0.3 v and below.

Spurious Harmonic Output: Less than 3%.

Leakage: Negligible; permits sensitivity measurements to 0.1 μv.

Amplitude Modulation: Continuously adjustable from 0 to 100%.

Internal Modulation: 0 to 100% sinusoidal modulation at 400 cps ±5% or 1000 cps ±5%.

Modulation Bandwidth: Dc to 20 kc maximum.

External Modulation: 0 to 100% sinusoidal modulation dc to 20 kc.

Envelope Distortion: Less than 3% envelope distortion from 0 to 70% modulation at output levels of 1 volt or less.

Spurious FM: 0.0025% or 100 cps, whichever is greater, at an output of 1 v or less and 30% amplitude modulation.

Spurious AM: Hum and noise sidebands are 70 db below carrier.

Price: (cabinet) $1,200.00. (rack mount) $1,185.00.

Data subject to change without notice. Prices f.o.b. factory.

HEWLETT-PACKARD COMPANY Represented in Canada by ATLAS INSTRUMENT CORPORATION, LTD.
50 Wingold Ave., Toronto, Ont.; 105-525 Seymour St., Vancouver, B.C.; 3333 Cavendish Blvd., Montreal, Que.

world's most complete line of signal generators

For further information mark No. 23 on Readers' Service Card

Engineers tuning EIMAC klystron amplifier at I.R.E. Show find it non-critical, reliable

For the first time outside field applications and test installations, engineers had an opportunity to tune an Eimac Klystron amplifier on the air during the I.R.E. Show and Convention in Toronto last month.

The klystron amplifier was operated at 800 megacycles with output power of one kilowatt. Engineers tuning this equipment were impressed with the simplicity of its non-critical operation. Participants found Eimac's external cavity klystrons as easy to tune as a lower frequency negative-grid amplifier.

This dramatic demonstration featured the same type of Eimac Klystron already famous for outstanding long-life, reliability and performance in such tropo-scatter systems as Dew Line, White Alice and Texas Towers.

An animated display depicting the effect of velocity modulation on electron flow illustrated the circuit isolation and thermal safety factors that make klystrons ideal for UHF microwave applications.

A wide selection of Eimac klystrons, reflex klystrons, traveling wave tubes and negative grid tubes were displayed. Exhibits of Eimac's advanced work in traveling wave tubes were of particular interest to engineers confronted with rugged environmental applications.

For detailed information on latest Eimac developments, write for your copy of "What's New With The Electron . . . 1959."

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